EVERYDAY

MARCH 1996

# PRACTICAL ELECTRONICS

NDT 180496
BRENTFORD SQUARE
NEWS PH 878 1882
01$ 6.90

£2.45

**FREE! INSIDE GREENWELD WINTER CATALOGUE SUPPLEMENT**

## MIND MACHINE MK III

Mind Entrainment for relaxation

## MULTI PURPOSE MINI AMP

*Use your Headphones with this general purpose/test amp*

## INFRA-RED ZAPPER

Fun shooting game – a Teach-In '96 project

## HIGH CURRENT P.S.U.

*Supplies up to 7·5A stabilised*

*Run your 12V equipment off the mains*

## INGENUITY UNLIMITED

Readers Circuit Ideas

THE NO. 1 INDEPENDENT MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

03
9 770262 361072

**SURVEILLANCE TELESCOPE** Superb Russian zoom telescope adjustable from 15x to 60x! complete with metal tripod (imposible to use without this on the higher settings) 66mm lense, leather carrying case £149 ref BAR69

**RADIATION DETECTOR SYSTEM** Designed to be wall mounted and connected into a PC, ideal for remote monitoring, whole building coverage etc. Complete with detector, cable and software. £19.95 ref BAR75.

**WIRELESS VIDEO BUG KIT** Transmits video and audio signals from a minature CCTV camera (included) to any standard television! All the components including a PP3 battery will fit into a cigarette packet with the lens requiring a hole about 3mm diameter. Supplied with telescopic aerial but a piece of wire about 4" long will still give a range of up to 100 metres. A single PP3 will probably give less than 1 hours use. **£99** REF EP79. (probably not licensable!)

**CCTV CAMERA MODULES** 46X70X29mm, 30 grams, 12v 100mA. auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm). Works directly into a scart or video input on a tv or video. IR sensitive. £79.95 ref EF137.

**IR LAMP KIT** Suitable for the above camera enables the camera to be used in total darkness! £5.99 ref EF138.

**TANDATA TD1400 VIEWDATA** Complete system comprising modem, infra red remote keyboard, psu, UHF and RGB output, phone lead, RS232 output, composite output. £9.95 ref BAR33.

**MAGNETIC CARD READERS** (Swipes) £9.95 Cased with flyleads, designed to read standard credit cards! they have 3 wires coming out of the head so they may write as well? complete with control elctronics PCB. just £9.95 ref BAR31

**PANORAMIC CAMERA OFFER** Takes double width photographs using standard 35mm film. Use in horizontal or vertical mode. Complete with strap £7.99 ref BAR1

**COIN OPERATED TIMER KIT** Complete with coinslot mechanism, adjustable time delay, relay output, put a coinslot on anything you like! TV,s, videos, fridges, drinks cupboards, HIFI. takes 50p's and £1 coins. DC operated, price just £7.99 ref BAR27.

**ZENITH 900 X MAGNIFICATION MICROSCOPE** Zoom, metal construction, built in light, shrimp farm, group viewing screen, lots of accessories. £29 ref ANAYLT.

**LUBITEL 166U** Twin lens Russian 2 1/4" sq reflex camera supplied with two free rolls of colour film, flip up magnifier, 3 element f 4.5 lens. £19.99 ref BAR36.

**AA NICAD PACK** Pack of 4 tagged AA nicads £2.99 ref BAR34

**PLASMA SCREENS 222x310mm, no data hence £4.99 ref BAR67**

**NIGHTSIGHTS** Model TZS4 with infra red illuminator, views up to 75 metres in full darkness in infrared mode, 150m range, 45mm lens, 13 deg angle of view, focussing range 1.5m to infinity. 2 AA batteries required. 950g weight. £210 ref BAR61. 1 years warranty

**FILIN-1** 150m range, 15 deg angle of view, focusing 10m-infinity, £179 ref BAR62. A separate infra red light is available at £30 ref BAR63.

**WHITE NIGHT SIGHTS** Excellent professional night sight, small, hand held with camoflaged carrying case £325. 1 years warranty.

**MEGA AIR MOVERS** 375 cubic feet per min!, 240v 200 watt, 2,800 rpm, reversable, 7"x7" UK made, new, Aluminium, current list price about £180 ours? £29.95 ref BAR35.

**LIQUID CRYSTAL DISPLAYS Bargain prices,**
16 character 2 line, 65x14mm £1.99 ref SM1612A
16 character 2 line, 99x24mm £2.99 ref SM1623A
20 character 2 line, 83x19mm £3.99 ref SM2020A
16 character 4 line, 62x25mm £5.99 ref SMC1640A

**TAL-1 110MM NEWTONIAN REFLECTOR TELESCOPE** Russian. Superb astronomical 'scope, everything you need for some serious star gazing! up to 169x magnification. Send or fax for further details £249 ref TAL-1

**GOT AN EXPENSIVE BIKE?** You need one of our bottle alarms, they look like a standard water bottle, but open the top, insert a key to activate a motion sensor alarm built inside. Fits all standard bottle carriers, supplied with two keys. **SALE PRICE £7.99** REF SA32.

**GOT AN EXPENSIVE ANYTHING?** You need one of our cased vibration alarms, keyswitch operated, fully cased just fit it to anything from videos to caravans, provides a years protection from 1 PP3 battery, UK made. **SALE PRICE £4.99** REF SA33.

**DAMAGED ANSWER PHONES** These are probably beyond repair so just £4.99 each. BT response 200 machines. REF SA30.

**COMMODORE GAMES CONSOLES** Just a few of these left to clear at £5 ref SA31. Condition unknown.

**COMPUTER DISC CLEAROUT** We are left with a lot of software packs that need clearing so we are selling at disc value only! 50 discs for £4, thats just 8p each!!(our choice of discs) **£4** ref EP66

**IBM PS2 MODEL 160Z CASE AND POWER SUPPLY** Complete with fan etc and 200 watt power supply. **£9.95** ref EP67

**DELL PC POWER SUPPLIES** 145 watt, +5,-5,+12,-12, 150x150x85mm complete with switch, flyleads and IEC socket. **SALE PRICE £9.99** ref EP55

**1.44 DISC DRIVES** Standard PC 3.5" drives but returns so they will need attention **SALE PRICE £4.99** ref EP68

**1.2 DISC DRIVES** Standard 5.25" drives but returns so they will need attention **SALE PRICE £4.99** ref EP69

**PP3 NICADS** Unused but some storage marks. £4.99 ref EP52

**DELL PC POWER SUPPLIES** (Customer returns) Standard PC psu's complete with fly leads, case and fan, pack of two psus **SALE PRICE £5 FOR TWO!!** ref EP61

**GAS HOBS AND OVENS** Brand new gas appliances, perfect for small flats etc. Basic 3 burner hob **SALE PRICE £24.99** ref EP72. Basic small built in oven **SALE PRICE £79** ref EP73

**BITS AND BOBS** We have a quantity of cased modems, multiplexers etc different specs but ideal strippers. **£4** each ref EP63

**RED EYE SECURITY PROTECTOR** 1,000 watt outdoor PIR switch **SALE PRICE £9.99** ref EP57

**ENERGY BANK KIT** 100 6"x6" 6v 100mA panels, 100 diodes, connection details etc. £69.95 ref EF112.

**PASTEL ACCOUNTS SOFTWARE**, does everything for all sizes of businesses, includes wordprocessor, report writer, windowing, networkable up to 10 stations, multiple cash books etc. 200 page comprehensive manual. 90 days free technical support (0345-326009 try before you buy!) **Current retail price is £129, SALE PRICE** £9.95 ref SA12. SAVE £120!!!

**WOLVERHAMPTON BRANCH NOW OPEN AT WORCESTER ST W'HAMPTON TEL 01902 22039**

**MINI MICRO FANS** 12V 1.5" sq **SALE PRICE £2**. Ref SA13.

**REUSEABLE HEAT PACKS**. Ideal for fishermen, outdoor enthusiasts elderly or infirm, warming food, drinks etc, defrosting pipes etc.reuseable up to 10 times, lasts for up to 8 hours per go, 2,000wh energy, gets up to 90 degC. **SALE PRICE £9.95** REF SA29

**12V 2AMP LAPTOP** psu's 110x55x40mm (includes standard IEC socket) and 2m lead with plug. 100-240v IP. **£6.99** REF SA15.

**PC CONTROLLED 4 CHANNEL TIMER** Control (on/off times etc) up to 4 items (8A 240v each) with this kit. Complete with Software, relays, PCB etc. £25.99 Ref 95/26

**COMPLETE PC 300 WATT UPS SYSTEM** Top of the range UPS system providing protection for your computer system and valuable software against mains power fluctuations and cuts.New and boxed, UK made Provides up to 5 mins running time in the event of complete power failure to allow you to run your system down correctly. **SALE PRICE just £89.00.**

**SOLAR PATH LIGHTS** Low energy walklights powered by the sun! built in PIR so they work when you walk past. Includes solar panel & rechargeable bat. **SALE PRICE £19.95** REF EP62

**BIG BROTHER PSU** Cased PSU, 6v 2A output, 2m o/p lead, 1.5m input lead, UK made, 220v. **SALE PRICE £4.99** REF EP7

**Check out our WEB SITE**

**http://www.pavilion.co.uk/bull-electrical**

**RACAL MODEM BONANZA!** 1 Racal MPS 1223 1200/75 modem, telephone lead, mains lead, manual and comms software, the cheapest way onto the net! all this for just £13 ref DEC13.

**4.5mw LASER POINTER. BRAND NEW MODEL NOW IN STOCK!, supplied in fully built form (looks like a nice pen) complete with handy pocket clip (which also acts as the on/off switch.) About 50 metres range! Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. just £39.95 ref DEC49 TRADE PRICE £28 MIN 10 PIECES**

**BULL TENS UNIT** Fully built and tested TENS (Transcutaneous Electrical Nerve Stimulation) unit, complete with electrodes and full instructions. TENS is used for the relief of pain etc in up to 70% of sufferers. Drug free pain relief, safe and easy to use, can be used in conjunction with analgesics etc. £49 Ref TEN/1

**COMPUTER RS232 TERMINALS. (LIBERTY)** Excellent quality modern units,(like wyse 50,s) 2xRS232, 20 function keys, 50 thro to 38,400 baud, menu driven port, screen, cursor, and keyboard setup menus (18 menu's). £29 REF NOV4.

**RUSSIAN MONOCULARS** Amazing 20 times magnification, coated lenses, carrying case and shoulder strap.£29.95 REF BAR73

**PC PAL VGA TO TV CONVERTER** Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware.. Ideal for laptops or a cheap upgrade.Supplied in kit form for home assembly. **SALE PRICE £25** REF SA34

**EMERGENCY LIGHTING UNIT** Complete unit with 2 double bulb floodlights, built in charger and auto switch. Fully cased. 6v 8AH lead acid req'd. (secondhand) £4 ref MAG4P11.

**SWINGFIRE GUIDED MISSILE WIRE.** 4,200 metre reel of ultra thin 4 core insulated cable, 28lbs breaking strain, less than 1mm thick! Ideal alarms, intercoms, dolls house's etc. **£13.99** ref EP51

**ELECTRIC CAR WINDOW DE-ICERS** Complete with cable, plug etc **SALE PRICE JUST £4.99** REF SA28

**ASTEC SWITCHED MODE PSU** BM41012 Gives +5 @ 3.75A, +12@1.5A, -12@.4A. 230/110, cased, BM41012. £5.99 ref AUG6P3.

**AUTO SUNCHARGER** 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. **£8.99** REF SA25.

**TOP QUALITY CENTRIFUGAL MAINS MOTORS SALE PRICE2 FOR JUST £2.50 REF SA38**

**ECLATRON FLASH TUBE** As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. **£6.99** REF SA15.

**24v AC 96WATT** Cased power supply. New. £9.99 REF SA40

**MILITARY SPEC GEIGER COUNTERS** Unused an straight from Her majesty's forces. **SALE PRICE £44** REF SA16

**MICRODRIVE STRIPPERS** Small cased tape drives ideal for stripping, lots of useful goodies including a smart case, and lots of components. **SALE PRICE JUST £4.99 FOR FIVE** REF SA26

**SOLAR POWER LAB SPECIAL** You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor. Superb value kit **SALE PRICE JUST £4.99** REF SA27

**RGB/CGA/EGA/TTL COLOUR MONITORS** 12" in good condition. Back anodised metal case. **SALE PRICE £49** REF SA16

**PLUG IN ACORN PSU** 19v AC 14w , £2.99 REF MAG3P10

**POWER SUPPLY** fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

**ACORN ARCHIMEDES PSU** +5v @ 4.4A. on/off sw uncased, selectable mains input, 145x100x45mm **£3.99** REF MAG7P2

**13.8V 1.9A PSU** cased with leads. Just £9.99 REF MAG10P3

**200 WATT INVERTER** Converts 10-15v DC into either 110v or 240v AC. Fully cased 115x36x156mm, complete with heavy duty power lead, cigar plug, AC outlet socket.Auto overload shutdown auto short circuit shut down, auto input over voltage shutdown, auto input under voltage shut down (with audible alarm), auto temp control, unit shuts down if overheated and sounds audible alarm. Fused reversed polarity protected. output frequency within 2%, voltage within 10%. A well built unit at an keen price. Just £64.99 ref AUG65.

**UNIVERSAL SPEED CONTROLLER KIT** Designed by us for the C5 motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 **REF: MAG17**

**COMPUTER COMMUNICATIONS PACK** Kit contains 100m of 6 core cable, 100 cable clips, 2 line drivers with RS232 interfaces and all connectors etc. Ideal low cost method of communicating between PC's over a long distance. Complete kit £8.99.

**VIEWDATA SYSTEMS** made by Phillips, complete with internal 1200/75 modem, keyboard, psu etc RGB and composite outputs, menu driven, autodialler etc. **SALE PRICE £12.99** REF SA18

**AIR RIFLES .22** As used by the Chinese army for training puposes, so there is a lot about! £39.95 Ref EF78. 500 pellets £4.50 ref EF80.

**PLUG IN POWER SUPPLY SALE FROM £1.50** Plugs in to 13A socket with output lead. three types available, 9vdc 150mA £1.50 ref SA19, 9vdc 200mA £2.00 ref SA20, 6.5vdc 500mA £2 ref SA21.

**VIDEO SENDER UNIT.** Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op. Price is £15 **REF: MAG15** 12v psu is £5 extra **REF: MAG5P2**

***FM CORDLESS MICROPHONE** Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 9v battery. Tuneable to any FM receiver. Price is £15 **REF: MAG15P1**

***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range up to 2 km in open country. Units measure 22x52x155mm. Including cases and earp'ces. 2xPP3 req'd. £30.00 pr. **REF: MAG30**

***FM TRANSMITTER KIT** housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever! why pay £700? or price is £15 REF: EF62 (kit) Transmits to any FM radio.

***FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies. 9v battery req'd. £14 REF: MAG14

**TALKING COINBOX STRIPPER COMPLETE WITH COINSLOT MECHANISMS** originally made to retail at £79 each, these units are designed to convert an ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else?? **SALE PRICE JUST £2.50** REF SA23

**GAT AIR PISTOL PACK** Complete with pistol, darts and pellets £12.95 Ref EF82B extra pellets (500) £4.50 ref EF80.

**6"X12" AMORPHOUS SOLAR PANEL** 12v 155x310mm 130mA. **SALE PRICE £4.99** REF SA24.

**FIBRE OPTIC CABLE BUMPER PACK** 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

**MIXED GOODIES BOX OF**
**MIXED COMPONENTS WEIGHING 2 KILOS**
**YOURS FOR JUST £5.99**

**4X28 TELESCOPIC SIGHTS** Suitable for all air rifles, ground lenses, good light gathering properties. £19.95 ref R/7.

**RATTLE BACKS** Interesting things these, small piece of solid perspex like material that it you try to spin it on the desk it only spins one way! in fact if you spin it the 'wrong' way it stops of its own accord and go's back the other way! £1.99 ref GI/J01.

**GYROSCOPES** Remember these? well we have found a company that still manufactures these popular scientific toys, perfect gift or for educational use etc. £6 ref EP70

**HYPOTHERMIA SPACE BLANKET** 215x150cm aluminised foil blanket, reflects more than 90% of body heat. Also suitable for the construction of two way mirrors! £3.99 each ref O/L041.

**LENSTATIC RANGER COMPASS** Oil filled capsule, strong metal case, large luminous points. Sight line with magnifying viewer. 50mm dia, 86gm. £10.99 ref O/K604.

**RECHARGE ORDINARY BATTERIES UP TO 10 TIMES!** With the Battery Wizard! Uses the latest pulse wave charge system to charge all popular brands of ordinary batteries AAA, AA, C, D, four at a time! Led system shows when batteries are charged, automatically rejects unsuitable cells, complete with mains adaptor. BS approved. Price is £21.95 ref EP31.

**TALKING WATCH** Yes, it actually tells you the time at the press of a button. Also features a voice alarm that wakes you up and tells you what the time is! Lithium cell included. £7.99 ref EP26.

**PHOTOGRAPHIC RADAR TRAPS CAN COST YOU YOUR LICENCE!** The new multiband 2000 radar detector can prevent even the most responsible of drivers from losing their licence! Adjustable audible alarm with 8 flashing leds gives instant warning of radar zones. Detects X, K, and Ka bands, 3 mile range, 'over the hill' 'around bends' and 'rear trap facilities. micro size just 4.25"x2.5"x.75", Can pay for itself in just one day! £79.95 ref EP3.

**SANYO NICAD PACKS** 120mmx14mm 4.8v 270 maH suitable for cordless phones etc. Pack of 2 just £5 ref EP78.

**3" DISCS** As used on older Amstrad machines, Spectrum plus3's etc £3 each ref BAR400.

**STEREO MICROSOPES BACK IN STOCK** Russian, 200x complete with lenses, lights, filters etc etc very comprehensive microscope that would normally be around the £700 mark, our price is just £299 (full money back guarantee) full details in catalogue. Ref 95/300.

**SOLAR POWERED CAR VENTILATOR** Simply fits along the top of the glass in a side window and provides a constant supply of fresh air in hot sunny conditions! keeps your car cool in summer. £19.95 ref s/vent.

***SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK**

# BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUSSEX .
BN3 5QT. (ESTABLISHED 50 YEARS).
MAIL ORDER TERMS: CASH, PO OR CHEQUE
WITH ORDER PLUS £3 P&P PLUS VAT.
PLEASE ALLOW 7-10 DAYS FOR DELIVERYPHONE ORDERS
WELCOME (ACCESS,VISA, SWITCH, AMERICAN EXPRESS)
TEL: 01273 203500
FAX 01273 323077
E-mail bull@pavilion.co.uk

**WE BUY SURPLUS STOCK FOR CASH**

## FREE CATALOGUE

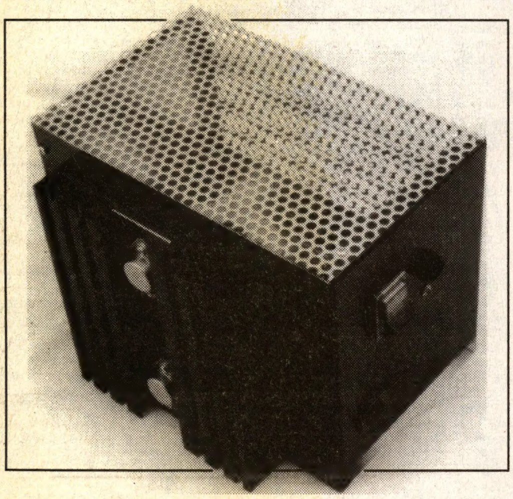
**100 PAGE CATALOGUE NOW AVAILABLE, 45P STAMP OR FREE WITH ORDER.**

**ISSN 0262 3617**
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

**VOL. 25 No. 3** **MARCH 1996**

# EVERYDAY PRACTICAL ELECTRONICS

**The No. 1 Independent Magazine for Electronics, Technology and Computer Projects**



© **Wimborne Publishing Ltd 1996. Copyright in all drawings, photographs and articles published in EVERYDAY PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.**

***Our April '96 Issue will be published on Friday, 1 March 1996. See page 171 for details.***

## *Projects*

**MIND MACHINE Mk III** by Andy Flind 182
Learn to relax with this completely updated Mind Entrainment aid

**MULTI-PURPOSE MINI AMPLIFIER** by Robert Penfold 194
Use your FREE cover-mounted headphones (UK issues only) with this versatile amplifier, it's ideal for almost any signal source

**INFRA-ZAPPER** by Max Horsey 210
Set your sights onto hot target practice! A *Teach-In '96* project

**HIGH CURRENT STABILISED PSU** by Steve Knight 220
Mains operated with a silky-smooth output from 12·5V to 16V at 7·5A

**PIC-ELECTRIC METER - 2** by John Becker 232
Know how much each electrical appliance is adding to your bill

## *Series*

**INGENUITY UNLIMITED** by Enthusiastic Readers 201
Rain Sensor; High Gain Transistor Amplifier; Property Alarm

**TEACH-IN '96 - A Guide to Modular Circuit Design - 5** by Max Horsey 204
How simple modules can be used as the building blocks for larger designs. I.R. receiver, encoder/decoder, bistables and pulsed Darlington outputs

**INTERFACE** by Robert Penfold 218
Feeling quizzical? – perhaps a 16-station quiz-master might be your answer

**AMATEUR RADIO** by Tony Smith G4FAI 244
IARP adopted by OAS; News from ISWL, and their 50th Anniversary; Repeater problems; Forthcoming LF allocation

## *Features*

**EDITORIAL** 181

**FOX REPORT** by Barry Fox 191
Encyclopaedic CDs and the problems of global data retrieval

**INNOVATIONS** 192
Everyday news from the world of electronics

**NEW TECHNOLOGY UPDATE** by Ian Poole 198
On the 3D scene, new developments are bringing a practical solution in sight

**OHM SWEET OHM** by Max Fidling 199
When technology fails to read the signs, it's Fidling's feline that provides the litteracy!

**BACK ISSUES** Did you miss these? 209

**SHOPTALK** with David Barrington 216
Component buying for EPE projects

**ELECTRONICS VIDEOS** Our range of educational videos 228

**PAL TRAINER REVIEW** by Chris Roberts 230
Reviewing an ideal training system for learning PLDs

**DIRECT BOOK SERVICE** 239
A wide range of technical books available by mail order

**PRINTED CIRCUIT BOARD SERVICE** PCBs for EPE projects 243

**ADVERTISERS INDEX** 248

**FREE**
**GREENWELD WINTER CATALOGUE SUPPLEMENT**
**between pages 208/209**

**STEREO HEADPHONES (UK issues only)** **Cover Mounted**

***Readers Services ● Editorial and Advertisement Departments 181***

Surplus always wanted for cash!

# THE *ORIGINAL* SURPLUS WONDERLAND!

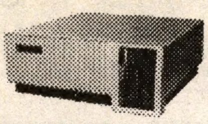
*THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS*

Surplus always wanted for cash!

## *LOW COST PC's -*

### *SPECIAL BUY*

### AT 286



### 40Mb HD + 3Mb Ram

**LIMITED QUANTITY** only of these **12Mhz HI GRADE 286** systems Made in the USA to an industrial specification, the system was designed for *total reliability*. The **compact case** houses the motherboard, PSU and EGA video card with single **5¼" 1.2 Mb** floppy disk drive & **integral 40Mb hard disk drive** to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with **enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee.** *Ready to Run !*

**Order as HIGRADE 286** ***ONLY £129.00*** (E)

| | |
|---|---|
| **Optional Fitted extras:** VGA graphics card | £29.00 |
| 1.4Mb 3½" floppy disk drive (instead of 1.2 Mb) | £19.95 |
| NE2000 Ethernet (thick, thin or twisted) network card | £39.00 |

### LOW COST 486DX-33 SYSTEM

**Limited quantity** of this 2nd user, supurb small size desktop unit. Fully featured with standard simm connectors 30 & 72 pin. Supplied with keyboard, 4 Mb of RAM, SVGA monitor output, 256k cache and integral 120 Mb IDE drive with single 1.44 Mb 3.5" floppy disk drive. Fully tested and guaranteed.

***Many other options avaiable - call for details.*** Only **£399.00** (E)

## *FLOPPY DISK DRIVES 3½" - 8"*

### *5¼" or 3½" from only £18.95 !*

Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are ***BRAND NEW*** or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. **All are IBM-PC compatible** (if 3½" supported on your PC).

| | |
|---|---|
| 3½" **Panasonic** JU363/4 720K or equivalent RFE | **£24.95**(B) |
| 3½" **Mitsubishi** MF355C-L. 1.4 Meg. Laptops only | **£25.95**(B) |
| 3½" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop | **£18.95**(B) |
| 5¼" **Teac** FD-55GFR 1.2 Meg (for IBM pc's) RFE | **£18.95**(B) |
| 5¼" **Teac** FD-55F-03-U 720K 40/80 (for BBC's etc) RFE | **£22.95**(B) |
| 5¼" **BRAND NEW Mitsubishi** MF501B 360K | **£22.95**(B) |
| Table top case with integral PSU for HH 5¼" Flopp or HD | **£29.95**(B) |
| **8" Shugart 800/801** 8" SS refurbished & tested | **£195.00**(E) |
| **8" Shugart 810** 8" SS HH *Brand New* | **£195.00**(E) |
| **8" Shugart 851** 8" double sided refurbished & tested | **£250.00**(E) |
| **Mitsubishi M2894-63 8"** double sided *NEW* | **£275.00**(E) |
| **Mitsubishi M2896-63-02U 8"** DS slimline *NEW* | **£285.00**(E) |
| **Dual 8"** cased drives with integral power supply 2 Mb | **£499.00**(E) |

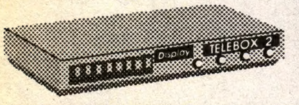
## *HARD DISK DRIVES*

**End of line purchase scoop!** Brand new **NEC D2246** 8" 85 Mbyte drive with **industry standard SMD interface**. Ultra hi speed data transfer and access times, replaces Fujitsu equivalent model. Complete with full manual. Only **£299.00 or 2 for £525.00** (E)

| | |
|---|---|
| 3½" **FUJI** FK-309-26 20mb MFM I/F RFE | **£59.95**(C) |
| 3½" **CONNER** CP3024 20 mb IDE I/F (or equiv )RFE | **£59.95**(C) |
| 3½" **CONNER** CP3044 40mb IDE I/F (or equiv.)RFE | **£69.00**(C) |
| 3½" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn) | **£99.00**(C) |
| 3½" **WESTERN DIGITAL** 850mb IDE I/F ***Brand New*** | **£185.00**(C) |
| 5¼" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE | **£49.95**(C) |
| 5¼" **SEAGATE** ST-238R 30 mb RLL I/F Refurb | **£69.95**(C) |
| 5¼" **CDC** 94205-51 40mb HH MFM I/F RFE tested | **£69.95**(C) |
| 8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested | **£195.00**(E) |
| Hard disc controllers for MFM , IDE, SCSI, RLL etc. **from** | **£16.95** |

## *THE AMAZING TELEBOX*

**Converts your colour monitor into a QUALITY COLOUR TV!!**



*TV SOUND & VIDEO TUNER*

*CABLE COMPATIBLE**

The **TELEBOX** is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as **MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD** etc. The composite video output will also plug directly into most video recorders, allowing reception of **TV channels not normally receivable on most television receivers*** (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. **TELEBOX MB** covers virtually all television frequencies VHF and UHF **including the HYPERBAND as used by most cable TV operators.** A composite video output is located on the rear panel for direct connection to most makes of monitor or **desktop computer video systems**. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

| | |
|---|---|
| **TELEBOX ST** for composite video input type monitors | **£36.95** |
| **TELEBOX STL** as ST but fitted with integral speaker | **£39.50** |
| **TELEBOX MB** Multiband VHF/UHF/Cable/Hyperband tuner | **£69.95** |

For overseas PAL versions state 5.5 or 6 mHz sound specification.
*For cable / hyperband reception Telebox MB should be connected to a cable type service. Shipping code on all Teleboxe's is (B)

## *DC POWER SUPPLIES*

*Virtually every type of power supply you can imagine. Over 10,000 Power Supplies Ex Stock Call for info / list.*

## *IC's -TRANSISTORS - DIODES*

**OBSOLETE - SHORT SUPPLY - BULK**

### 6,000,000 items EX STOCK

**For *MAJOR* SAVINGS - CALL FOR SEMICONDUCTOR HOTLIST**

## *VIDEO MONITOR SPECIALS*

### One of the highest specification monitors you will *ever* see - At this price - Don't miss it!!

**Mitsubishi FA3415ETKL** 14" SVGA **Multisync** colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including **IBM PC's** in CGA, EGA, VGA & SVGA modes, **BBC, COMMODORE** (including Amiga 1200), **ARCHIMEDES** and **APPLE.** Many features: Etched faceplate, text switching and **LOW RADIATION MPR** specification. Fully guaranteed, supplied in EXCELLENT little used condition.

**Tilt & Swivel Base £4.75**
**VGA cable for IBM PC included.**
**External cables for other types of computers CALL**

**Only £119** (E) **Order as MITS-SVGA**

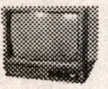
*5000 Monitors from stock !!!*
*HERCULES, EGA, CGA, VGA, SVGA - 6 to 26"*
*+ Many special items - CALL with your needs !*

**Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors.**
**Good SH condition - from £299 - CALL for Info**

**PHILIPS HCS35** (same style as CM8833) attractively styled 14" colour monitor with **both** **RGB and standard composite 15.625 Khz video inputs** via **SCART socket** and separate phono jacks. Integral audio **power amp and speaker** for **all audio visual uses.** Will connect direct to **Amiga and Atari** BBC computers. Ideal for all **video monitoring / security** applications with **direct connection to most colour cameras**. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £95** (E)

**PHILIPS HCS31** Ultra compact 9" colour video monitor with **standard composite 15.625 Khz video** input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered. **Only £79.00** (D)

**KME 10"** 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13½" x 12" x 11". Good used condition. **Only £125** (E)



### 20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & ***optional*** sound input. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs, etc.In EXCELLENT little used condition with full 90 day guarantee.

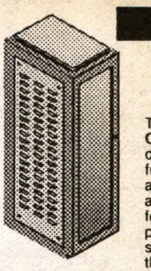
**20"....£135 22"....£155 26"....£185** (F)

## *SPECIAL INTEREST ITEMS*

| | |
|---|---|
| **MITS.** **FA3445ETKL** 14" Industrial spec SVGA monitors | **£245** |
| **2kW to 400 kW - 400 Hz 3 phase power sources - ex stock** | **£POA** |
| **Broadcast Electronics Inc** FX30 FM exciter 80-108 MHz | **£750** |
| **Stanelco STA15** 15kW RF Induction heater system | **£POA** |
| **IBM 8230** Type 1, Token ring base unit driver | **£950** |
| **IBM 53F5501** Token Ring ICS 20 port lobe modules | **£750** |
| **IBM MAU** Token ring distribution panel 8228-23-5050N | **£95** |
| **AIM 501** Low distortion Oscillator 9Hz to 330Khz, IEEE | **£550** |
| **Trend DSA 274** Data Analyser with G703(2M) 64 i/o | **£POA** |
| **HP APOLLO RX700** system units | **£950** |
| **HP6621A** Dual Programmable GPIB PSU 0-7 V 160 watts | **£1800** |
| **HP6264** Rack mount variable 0-20V @ 20A metered PSU | **£675** |
| **HP54121A** DC to 22 GHz four channel test set | **£POA** |
| **HP7580A** A1 8 pen HPGL high speed drum plotter | **£1850** |
| **Marconi 6310** Programmable 2 to 22 GHz sweep generator | **£6500** |
| **EG-NG Brookdeal 95035C** Precision lock in amp | **£650** |
| **OTC Ltd** 1550 SM Stabilised IR laser calibration source | **£2250** |
| **Ling Dynamics** 2kW programmable vibration test system | **£POA** |
| **Computar** 16mm CCTV auto iris lenses 'C' mount - NEW | **£125** |
| **Keithley 590 CV** capacitor / voltage analyser | **£POA** |
| **Racal ICR40** dual 40 channel voice recorder system | **£3750** |
| **Roken 80-250** 240v single phase flow solder machine | **£1200** |
| **ICI R5030UV34** Cleanline ultrasonic cleaning system | **£POA** |
| **Mann Tally MT645** High speed line printer | **£2200** |
| **INTEL SBC 486/133SE** Multibus 486 system. 8Mb Ram | **£1200** |
| **Zeta 3220-05** A0 4 pen **HPGL** *fast* drum plotters | **£1150** |
| **Nikon HFX-11** (Ephiphot) exposure control unit | **£1450** |
| **Motorola VME** Bus Boards & Components List. SAE / CALL | **£POA** |
| **Trio** 0-18 vdc linear, metered 30 amp bench PSU. New | **£550** |
| **Fujitsu M3041R** 600 LPM band printer | **£1950** |
| **Fujitsu M3041D** 600 LPM printer with network interface | **£1250** |
| **Perkin Elmer 2998** Infrared spectrophotometer | **£POA** |
| **VG Electronics 1035** TELETEXT Decoding Margin Meter | **£3750** |
| **Andrews LARGE** 3.1 m Satellite Dish + mount (For Voyager!) | **£950** |
| **Thurlby** LA 160B logic analyser | **£375** |
| **Sekonic SD 150H** 18 channel digital Hybrid chart recorder | **£1995** |
| **Densei MUD 0185AH** 1KVa UPS system with batts NEW | **£575** |
| **System Video 1152** PAL waveform monitor | **£485** |
| **Test Lab** - 2 mtr square quietised acoustic test cabinets | **£300** |
| **Kenwood 9601** PAL Vectorscope - NEW | **£650** |

***Please call for further details on the above items***

## *19" RACK CABINETS*

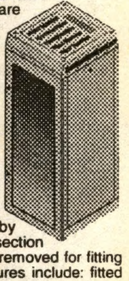


### Superb quality 6 foot 40U
### Virtually New, Ultra Smart
### *Less than Half Price!*

Top quality 19" rack cabinets made in UK by **Optima Enclosures Ltd**. Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the **most versatile we have ever sold.** Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays. Overall dimensions are: 77½" H x 32½" D x 22" W. **Order as:**

| | |
|---|---|
| **OPT Rack 1** Complete with removable side panels. | **£335.00** (G) |
| **OPT Rack 2** Rack, Less side panels | **£225.00** (G) |

### 32U - High Quality - All steel RakCab



Made by **Eurocraft Enclosures** Ltd to the **highest possible spec,** rack features **all steel construction** with removable side, front and back doors. Front and back doors are **hinged for easy access** and all are lockable with five **secure 5 lever barrel locks**. The front door is constructed of double walled steel with a **'designer style'** smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack features fully slotted reinforced vertical fixing members to **take the heaviest of 19" rack equipment.** The two movable vertical fixing struts (extras available) are pre punched for standard 'cage nuts'. A **mains distribution panel** internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin **switched utility socket.** Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvres. The top panel may be removed for fitting of **integral fans** to the sub plate etc. Other features include: fitted castors and floor levelers, prepunched utility panel at lower rear for cable / connector access etc. Supplied in **excellent,** slightly used condition with keys. Colour Royal blue. External dimensions mm=1625H x 635D x 603 W. ( 64" H x 25" D x 23¾" W )

***Sold at LESS than a third of makers price !!***

**A superb buy at only £195.00** (G)

*Over 1000 racks* **- 19" 22" & 24" wide**
**3 to 44 U high. Available from stock !!**
**Call with your requirements.**

## *TOUCH SCREEN SYSTEM*

The ultimate in **'Touch Screen Technology'** made by the experts - ***MicroTouch*** - but sold at a **price below cost !!** System consists of a flat translucent glass laminated panel measuring 29.5 x 23.5 cm connected to an electronic controller PCB. The controller produces a **standard serial RS232** or TTL output which continuously gives simple serial data containing positional X & Y co-ordinates as to where a finger is touching the panel - as the finger moves, the data instantly changes. The X & Y information is given at an **incredible matrix resolution of 1024 x 1024** positions over the entire screen size !! **A host of available translation software** enables direct connection to a PC for a myriad of applications including: control panels, pointing devices, POS systems, controllers for the disabled or computer un-trained etc etc. Imagine using your finger with 'Windows', instead of a mouse !! (a driver is indeed available !) ***The applications for this amazing product are only limited by your imagination!!*** Complete system including Controller, Power Supply and Data supplied at an incredible price of only: ***£145.00*** (B)

***Full MICROTOUCH software support pack and manuals for IBM compatible PC's £29.95 RFE - Tested***

## *LOW COST RAM & CPU'S*

**INTEL 'ABOVE' Memory Expansion Board**. Full length PC-XT and PC-AT compatible card with **2 Mbytes** of memory on board. Card is fully selectable for Expanded or Extended (286 processor and above) memory. **Full data and driver disks supplied**. RFE. Fully tested and guaranteed. Windows compatible. **£59.95**(A1)

**Half length 8 bit memory upgrade cards** for PC AT XT expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.

**Order as: XT RAM UG. 256k. £34.95** *or* **512k £39.95** (A1)

**SIMM** **SPECIALS**

| | | |
|---|---|---|
| **1 MB x 9 SIMM** 9 chip 120ns | **Only** | **£19.50** (A1) |
| **1 MB x 9 SIMM** 3 chip 80 ns **£23.50** | or 70ns | **£24.95** (A1) |
| **1 MB x 9 SIMM** 9 chip 80 ns **£22.50** | or 70ns | **£24.00** (A1) |
| **4 MB 70 ns** 72 pin SIMM ***-with parity-*** | **Only** | **£95.00** (A1) |
| **8 MB 70 ns** 72 pin SIMM - no parity | | **£159.00** (A1) |
| **INTEL 486-DX33 CPU £55.00** **INTEL 486-DX66 CPU** | | **£69.00** (A1) |

## *FANS & BLOWERS*

| | | |
|---|---|---|
| **EPSON DO412** 40x40x20 mm 12v DC | £7.95 | 10 / £65 |
| **PAPST TYPE 612** 60x60x25 mm 12v DC | £8.95 | 10 / £75 |
| **MITSUBISHI MMF-D6D12DL** 60x60x25 mm 12v DC | £4.95 | 10 / £42 |
| **MITSUBISHI MMF-08C12DM** 80x80x25 mm 12v DC | £5.25 | 10 / £49 |
| **MITSUBISHI MMF-09B12DH** 92x92x25 mm 12v DC | £5.95 | 10 / £53 |
| **PANCAKE 12-3.5** 92x92x18 mm 12v DC | £7.95 | 10 / £69 |

**EX-EQUIP AC fans. ALL TESTED** 120 x 120 x 38 mm specify 110 or 240 v **£6.95.** 80 x 80 x 38 mm - specify 110 or 240 v **£5.95**
**IMHOF B26 1900** rack mnt 3U x 19" Blower 110/240v NEW **£79.95**
Shipping on all fans (A). Blowers (B). ***50,000 Fans Ex Stock CALL***

**Issue 13 of *Display News* now available - send large SAE - PACKED with bargains!**

DISPLAY
-ELECTRONICS-

ESTABLISHED
25 YEARS

ALL MAIL & OFFICES
Open Mon-Fri 9.00-5:30
Dept PE. 32 Biggin Way
Upper Norwood
LONDON SE19 3XF

LONDON SHOP
Open Mon - Sat 9:00 - 5:30
215 Whitehorse Lane
South Norwood
On 68A Bus Route
Nr.Thornton Heath &
Selhurst Park SR Rail Stations

NEW DISTEL©
The Original
FREE On line Database
Info on 20,000 + stock items!
RETURNING SOON !

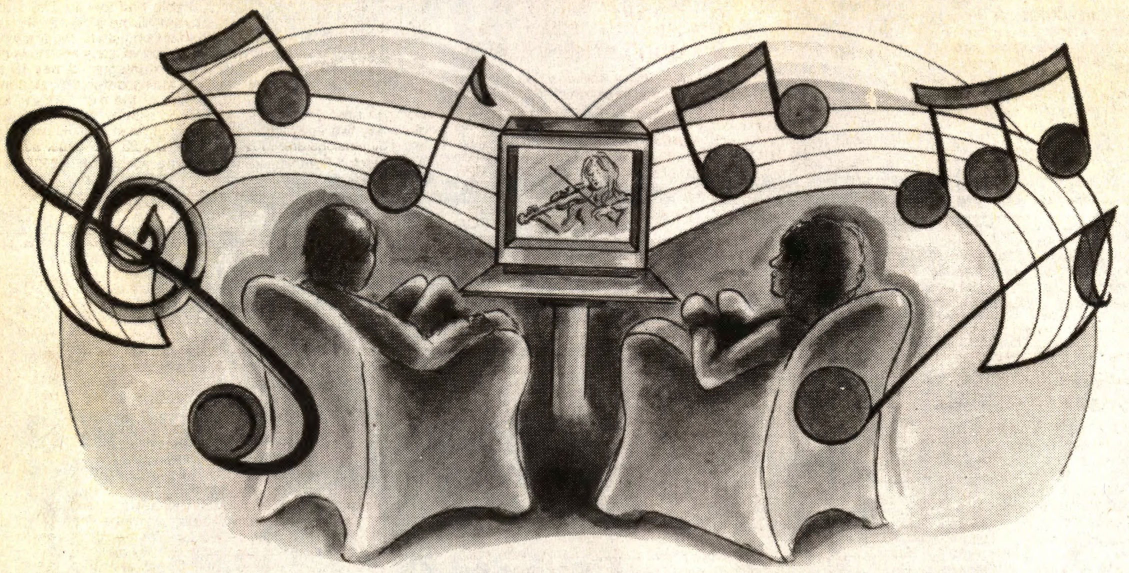
*ALL ☎ ENQUIRIES*
**0181 679 4414**
*FAX 0181 679 1927*

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. Scotland surcharge CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks etc acknowledged. © Display Electronics 1996. E & O E. 01/5

# NEXT MONTH

# FREE! DOLBY PRO-LOGIC BOOKLET with all copies.

*Ever wondered how the amazing "cinema sound" can be recreated in your home by the Dolby Pro-Logic system? This booklet explains exactly how the processor works and what is required to reproduce the "cinema sound" in your front room. Not only that, it gives full constructional details for the only d.i.y. kit available in the world for a:*



# DOLBY PRO-LOGIC DECODER...

*which you can build for under £100 (plus case). This is the genuine article, approved and licensed by Dolby Laboratories in California.*

***Don't miss the project of the decade – order your copy now!***

## BAT BAND CONVERTER

*Find out if you've got bats in your belfry! This clever device converts the bat's ultrasonic calls into a medium wave signal for reception on a small portable a.m. radio. Uses the latest technology – a Surface Mount Device.*

## HEARING TESTER

*Arguably, next to sight, hearing is our second most valuable sense. Consequently, it can be reassuring to have its quality assessed in terms of frequency and amplitude threshold response.*

*The Hearing Tester offers a means of doing a non-medical check of how well your ears behave.*

**PLUS Special Feature**

## VALVES TODAY

*The trusty thermionic valve still finds uses in a wide variety of applications. Whilst it may not seem like the latest in technology, valves still have their place in today's equipment. This feature looks at the history and present day use of valves in general.*

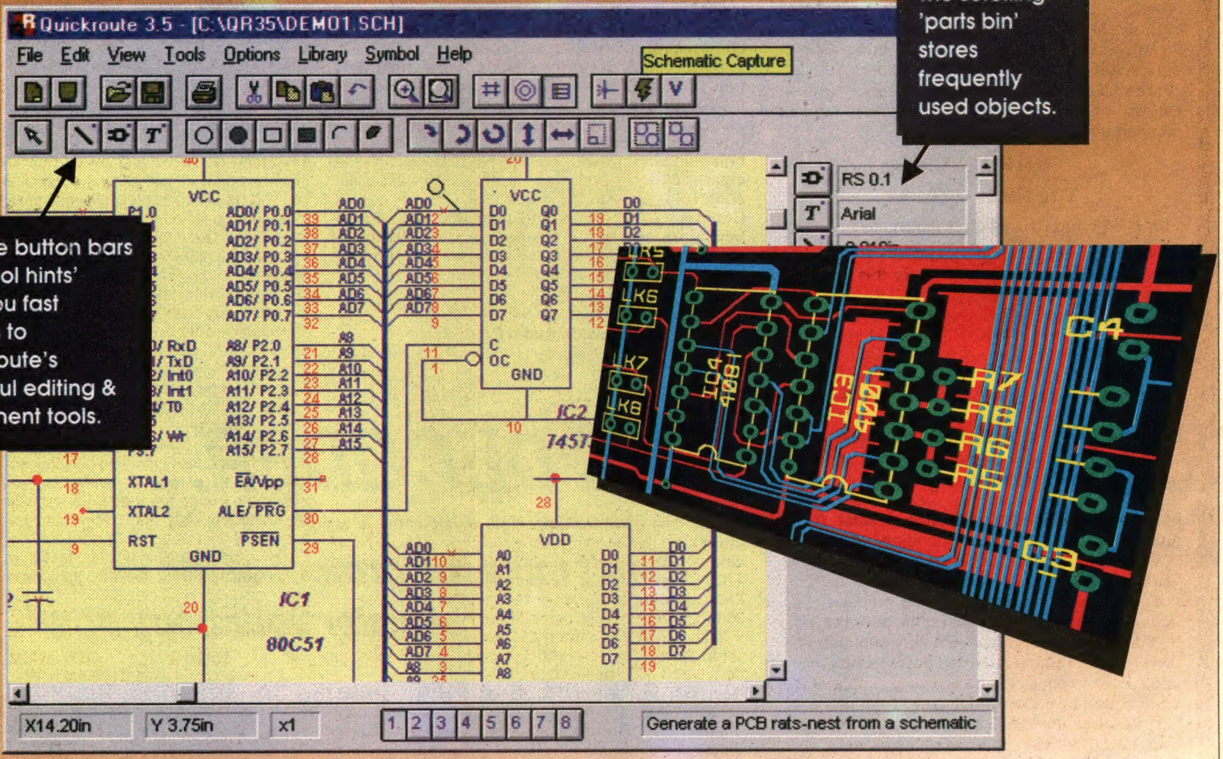
**EVERYDAY PRACTICAL ELECTRONICS**

**APRIL ISSUE ON SALE FRIDAY, MARCH 1**

QUICKROUTE™

New Version 3.5

# Integrated PCB & Schematic Design System for Windows™



The scrolling 'parts bin' stores frequently used objects.

Multiple button bars with 'tool hints' give you fast access to Quickroute's powerful editing & placement tools.

**"..of all the products included here, this is my personal favourite... Really, thats all I have to say about Quickroute - it certainly gets my vote!"**

**Review of QR 3.0 & other products**
**Computer Shopper Nov 95**

EASY TO USE
Quickroute 3.5 is a powerful, affordable and easy to use integrated schematic & PCB design system for Windows. With its multiple button bars, 'tool hints' and 'parts bin', Quickroute helps you to design quickly and efficiently

POWERFUL
There are four different versions of Quickroute giving you a choice of features & price. Quickroute is available with multi-sheet schematic capture, auto-routing, 'engineering change' (modification of a PCB from a schematic), copper fill, and a range of file import/export options. See the table for a selection of features.

AFFORDABLE
Prices are Designer (£149), PRO (£249) and PRO+ (£399). The Personal edition is available for just £68, but has the manual provided on disk as on-line help. Post & Packing is £5 (UK), £8 (EC), £12 (World). VAT must be added to the total price.

| | Personal | Designer | PRO | PRO+ |
|---|---|---|---|---|
| PCB & Schematic Design | ✓ | ✓ | ✓ | ✓ |
| Schematic Capture | | ✓ | ✓ | ✓ |
| Auto router | | | ✓ | ✓ |
| Design Rule Checking | | | ✓ | ✓ |
| Export WMF & Tango | | | ✓ | ✓ |
| Export Gerber/NC-Drill | | | ✓ | ✓ |
| Extended Libraries | | | ✓ | ✓ |
| Tango + Gerber Import | | | | ✓ |
| Update PCB from schematic | | | | ✓ |
| DXF & SPICE Export | | | | ✓ |
| Copper Fill | | | | ✓ |

## Tel/Fax 0161 449 7101

QUICKROUTE SYSTEMS

MasterCard VISA SWITCH

Quickroute Systems Ltd., 14 Ley Lane, Marple Bridge,
Stockport, SK6 5DD, U.K.

email info@quicksys.demon.co.uk

Phone now for more information

Prices and specifications subject to change without notice. All trade marks are acknowledged & respected.

# HART AUDIO KITS – YOUR VALUE FOR MONEY ROUTE TO ULTIMATE HI-FI

HART KITS give you the opportunity to build the very best engineered hifi equipment there is, designed by the leaders in their field, using the best components that are available.

Every HART KIT is not just a new equipment acquisition but a valuable investment in knowledge, giving you guided hands-on experience of modern electronic techniques.

In short HART is your 'friend in the trade' giving you, as a knowledgeable constructor, access to better equipment at lower prices than the man in the street.

You can buy the reprints and construction manual for any kit to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

Our list will give you full details of *all* our Audio Kits, components and special offers.

## INTRODUCING

## The Hart *''Chiara''*

### Single-Ended Class "A" Headphone Amplifier.

Most modern high fidelity amplifiers either do not have a headphone output facility, or this may not be up to the highest standard.

The new Hart "Chiara" has been introduced as an add-on unit to remedy this situation, and will provide two ultra high quality headphone outlets. This is the first unit in our 2000 Range of modules to be introduced through the year. Housed in the neat, black finished, Hart Minibox it features the wide frequency response, low-distortion and "musicality" that one associates with designs from the renowned John Linsley Hood.

Both outputs will drive any standard high quality headphones with an impedance greater than 30 ohms and the unit is ideal for use with the Sennheiser range. A signal link-through makes it easy to incorporate into your system and two extra outputs, one at output level and one adjusted by the Volume control are available on the back panel. The high level output also makes a very useful long-line driver where remote mounted power amplifiers are used. Power requirements are very simple and can be provided by either of our new "Andante" power supplies. Use the K3565 to drive the "Chiara" on its own, K3550 if driving other modules as well.

Volume and Balance controls are provided and as befits any unit with serious aspirations to quality these are the ultra high quality Alps "Blue Velvet" components.

Very easily built, even by beginners, since all components fit directly on the single printed circuit board and there is no conventional wiring whatsoever. The kit has very detailed instructions, and even comes with a roll of Hart audiograde silver solder. It can also be supplied factory assembled and tested.

Selling for less than the total cost of all the components, if they were bought separately, this unit represents incredible value for money and makes an attractive and harmonious addition to any hifi system.

**K2100** The total cost of a complete set of all components to build this unit is £126.37. Our **special discount price** for all parts bought together as a kit is........................................................................**£109.50**

**K2100SA** Series Audiophile, with extra selected components....................................................**£112.46**

### HART TC1D *Triple Purpose* TEST CASSETTE

Now available again and even better than before! Our famous triple purpose test cassette will help you set up your recorder for peak performance after fitting a new record/play head. This quality precision Test Cassette is digitally mastered in real time to give you an accurate standard to set the head azimuth, Dolby/VU level and tape speed, all easily done without test equipment.

TC1D Triple Purpose Test Cassette....................£9.99

## NEW BOOK

## *''Audio Electronics''*

And now, hot off the press, yet another classic from the pen of John Linsley Hood. Following the ongoing enormous success of his ''Art of Linear Electronics'' the latest offering is the all-new edition of ''Audio Electronics'', now entirely re-written by the master himself.

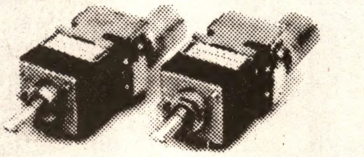
Underlying audio techniques and equipment is a world of electronics that determines the quality of sound. For anyone involved in designing, adapting or using digital or analogue audio equipment understanding electronics leads to far greater control over the reproduced sound.

The subjects covered include tape recording, tuners, power output stages, digital audio, test instruments and loudspeaker crossover systems. John's lifetime of experience and personal innovation in this field allow him to apply his gift of being so familiar with his subject that he can write clearly about it and make it both interesting and comprehensible to the reader.

Containing 240 pages and over 250 line illustrations this new book represents great value for money at only £18.99 plus £2.50 postage. Send or telephone for your personal copy now.

## ALPS *''Blue Velvet''*

### Precision Audio Controls



To fulfil the need for ultra high quality controls we import a special range of precision audio pots in values to cover most quality amplifier applications. All in 2-gang stereo format, with 20mm long 6mm diam. steel shafts, except for the 50K Log which is 25mm x 6mm. Overall size of the manual pot is 27W x 24H x 27Deep, motorised versions are 72·4mm Deep from the mounting face. Mounting bush for both types is 8mm diameter.

Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability.

The motorised versions use a 5V DC motor coupled to the normal control shaft with a friction clutch so that the control can be operated manually or electrically. The idea of having electrically operated pots may seem odd, archaic even, but it is in fact the only way that remote control can be applied to any serious Hi-Fi system without loss of quality. The values chosen are the most suitable available for a low loss passive volume and balance control system, allowing armchair control of these two functions.

Our prices represent such super value for pots of this quality due to large purchases for our own kits.

| | |
|---|---|
| MANUAL POTENTIOMETERS | |
| 2-Gang 100K Lin | £15.67 |
| 2-Gang 10K, 50K or 100K Log. | £16.40 |
| 2-Gang 10K Special Balance, zero crosstalk and zero centre loss | £17.48 |
| MOTORISED POTENTIOMETERS | |
| 2-Gang 20K Log Volume Control | £26.20 |
| 2-Gang 10K RD Special Balance, zero crosstalk and less than 10% loss in centre position | £26.98 |

### REEL TO REEL HEADS

999R 2/4 R/P 100mH..........................................£16.84

We have a few erase heads to suit which can only be supplied when 2 R/P heads are purchased £36.80

### TAPE RECORDER CARE PRODUCTS

| | |
|---|---|
| DEM1 Mains Powered Tape Head Demagentizer, prevents noise on playback due to residual head magentisation | £4.08 |
| DEM115 Electronic, Cassette Type, demagnetizer | £8.61 |

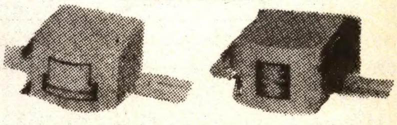
## LINSLEY HOOD 'SHUNT FEEDBACK' RIAA MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIERS

The HART K1450 Magnetic pickup preamplifier kit features a totally discrete component implementation with a specially designed low input impedance front end and the superior sound of the Shunt Feedback circuitry. High quality components fitting to an advanced double-sided printed circuit board make this a product at the leading edge of technology that you will be proud to own. Nevertheless with our step by step instructions it is very easy and satisfying to assemble. The higher current consumption of this unit means that it is best powered by our new ***Andante*** Audio Power Supply, itself an advanced piece of technology in a matching case. This supplies the superbly smoothed and stabilised supply lines needed by any sensitive preamplifer and features a fully potted Hi-grade toroidal transformer along with a special limited shift earth system for hum free operation. The K1450 is suitable for all moving coil and moving magent transducers this unit is especially recommended for, and will extract the very best from the modern generation of low output high quality moving coil transducers.

**K1450** Kit, complete with all parts ready to assemble inside the fully finished 228mm x 134mm x 63mm case. Kit includes full, easy to follow, assembly instructions as well as the Hart Guide to PCB Construction, we even throw in enough Hart Audiograde Silver Solder to construct your kit! ...................................................................................**£111.58**

**K1450SA** Series Audiophile version with selected components....................................................**£133.94**

### HIGH QUALITY REPLACEMENT CASSETTE HEADS



Do your tapes lack treble? A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1,500 hours. Fitting one of our high quality replacement heads could restore performance to better than new! Standard inductances and mountings make fitting easy on nearly all machines (Sony are special dimensions, we do not stock) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see! All our heads are suitable for use with any Dolby system and are normally available ex-stock. We also stock a wide range of special heads for home construction and industrial users.

| | |
|---|---|
| HC80 NEW RANGE High Beta Permalloy Stereo head. Modern space saver design for easy fitting and lower cost. Suitable for chrome, metal and ferric tapes, truly a universal replacement head for everything from hi-fi decks to car players and at an incredible price too! | £11.70 |
| HRP373 Downstream monitor combi head | £62.59 |
| HQ551A 4-Track R/P | £8.75 |
| HQ551S Sony Mount 4-Tr. R/P | £14.90 |
| HQR560 Rotary Base 12·5mm R/P/E | £21.90 |
| HQR570 Rotary Base 15mm R/P/E | £22.59 |
| HQR580 Rotary Base 12·5mm R/P | £14.29 |

### HART *Classical* CD's.

Top quality, Full Digital (DDD), over 100 titles from only **£1.99!** Ring or send for your list!

### TECHNICAL BOOKSHELF

We stock a good range of books of interest to the electronics and audio enthusiast, including many reprinted classics from the valve era. Some were in last months advertisement, but see our list for the full range.

New this month is the GEC Valve designs book at **£18.95,** and the VTL Book, a modern look at valve designs, **£17.95.**

Send or 'phone for your copy of our **FREE** List of these and many other Kits & Components. Enquiries from Overseas customers are equally welcome, but PLEASE send 2 IRCs if you want a list sent surface post, or 5 for Airmail.

Ordering is easy. Just write or telephone your requirements to sample the friendly and efficient HART service. Payment by cheque, cash or credit card. A telephoned order with your credit card number will get your order on its way to you THAT DAY.

Please add part cost of carriage and insurance as follows:–**INLAND Orders up to £20 - £1.50, Orders over £20 - £3.50. Express Courier, next working day £10.**

**OVERSEAS – Please see the ordering information with our lists.**

QUALITY
AUDIO KITS

24 hr. SALES LINE
(01691) 652894

ALL PRICES
INCLUDE
UK/EC VAT

HART ELECTRONIC KITS LTD.
8 PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

# ELECTRONICS SOFTWARE

**If you are looking for a means of improving your knowledge of the basics of electronics then this software is for you.**

## ELECTRONICS PRINCIPLES 2.1

**★ Insulators, Conductors, Resistance ★ D.C. Circuits**
**★ Capacitance and Inductance ★ A.C. Series Circuits**
**★ A.C. Parallel Circuits ★ Reactance and Impedance**
**★ A.C. and D.C. Power ★ Frequency and Tuned Circuits**
**★ Using Numbers ★ Complex Numbers, Phase Angles**
**★ P.N. Junction Diode ★ Bi-polar and MOSFET Transistors**
**★ Operational Amplifiers ★ Logic Gates ★ Digital Number Systems**
**★ Combinational Logic ★ Flip Flops ★ Counters and Shift Registers**
**★ Memory ★ Microcomputer operation**

Now an extended range of electronics topics with an improved graphics presentation, available to electronics hobbyists, students, schools, colleges, and used for training within industry throughout the UK and overseas. A fully interactive electronics program where the user selects from over 250 analogue and digital topics. Circuit diagrams, wave forms, phase angles, voltages and currents or logic states are shown, drawn to scale, in full colour. Formulae are given demonstrating all the calculation steps, exactly as in a textbook, using your input values.

An 'on screen' electronics package including circuit theory to enable a learning through doing approach to encourage experimentation. For the young student, mature hobbyist or the engineer that just needs to keep up-to-date in an easy and enjoyable way.

*Having reviewed a dozen, or more, educational software packages designed to "teach" electronics, I was more than a little sceptical when I first heard about* Electronics Principles*: there seemed to be little that could be done that has not been done elsewhere. When I started to use the package my views changed. Indeed, I was so impressed with it that I quickly came to the conclusion that readers should have an opportunity to try the package out for themselves!* – MIKE TOOLEY B.A. Dean of Faculty of Technology, Brooklands Technical College.

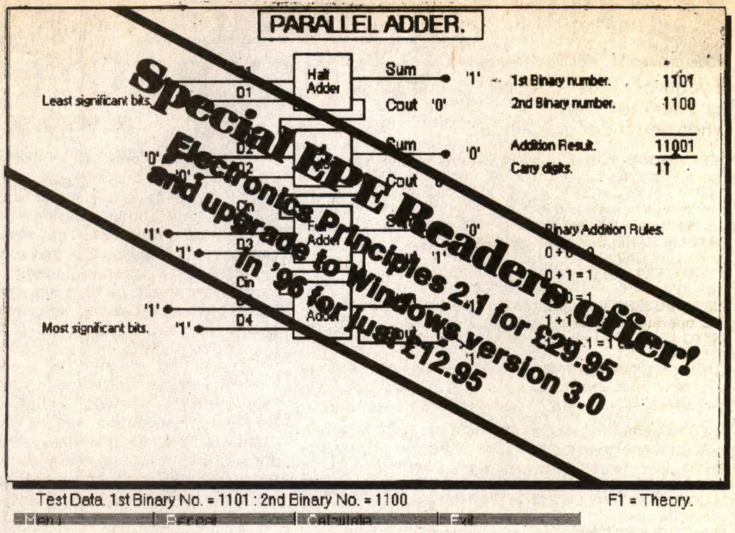
**Complete package Still only £49.95**

## ELECTRONICS PC TOOLBOX VERSION 2.0

An extended and improved version of the popular Toolbox software. Presents commonly used formulae in a way that makes calculations easier thus encouraging experimentation in circuit design.

Covers **D.C. Calculations** from Ohm's Law to Loading a Potential Divider; **Further D.C. Calculations** from Power Ratio Decibels to Kirchhoff's Laws; **A.C. Calculations** from Average Peak Current to Filters and Admittance; **Capacitance Calculations** from Values to RC Time Constants; **Inductance Calculations** from Values to Selectivity; **Binary Calculations** from Addition to 2's Complement; **Numbers and Phase Angles** from Addition to Polar to Rectangular; **Operational Amplifiers** from Inverting Op.Amp to Op.Amp Differentiator.

**Only £19.95**



**Special EPE Readers offer!**
**Electronics Principles 2.1 for £29.95 and upgrade to Windows version 3.0 in '96 for just £12.95**

Test Data. 1st Binary No. = 1101 : 2nd Binary No. = 1100

F1 = Theory.

## GCSE ELECTRONICS VERSION 2.0

Designed to complement the *EPE Teach-In No. 7* publication, which contains a complete electronics course aimed at GCSE and A Level students, this software can also be used as a stand alone learning package for everyone interested in electronics. From simple d.c. current flow and Ohm's Law it covers the whole GCSE syllabus including a.c., semiconductors, op.amps, digital electronics, radio and fibre optic communications, digital numbering systems and goes on to look at microprocessor c.p.u.s, 6502 addressing modes and instruction sets. It even produces a program listing, which can be saved or retrieved from hard disk, when any of the instructions from the listed instruction set are input, thus allowing the user to monitor the registers for each of the addressing modes.

The original version is now widely used in schools and colleges throughout the UK.

An interactive, user friendly medium which assists learning in an enjoyable and interesting way.

**Only £39.95**

For more information or software upgrades call us on 01376 514008

## GCSE MATHS now version 2.0

A series of programs **covering all the major topics** required by the school syllabus. Designed to be user friendly enabling you to study or revise in what we believe is an interesting and enjoyable way. There are nearly one hundred and fifty menu driven screens with interactive graphics, enabling a "learning through doing" approach to encourage experimentation. Now being used in many schools throughout the UK.

**Only £49.95**

## JUST FOR FUN!

**EPT Lottery Selector. Windows version.**
**£5.00** + £1 p&P

---

These programs require an IBM compatible PC running DOS or Windows. We also recommend the use of a mouse.
For school and college site licence details – please enquire.

**Available from**

**EPT Educational Software,** Pump House, Lockram Lane, Witham, Essex. UK. CM8 2BJ. Tel/Fax: 01376 514008.
**E-Mail Address.** sales@eptsoft.demon.co.uk **WWW Pages.** http://www.octacon.co.uk/ext/ept/software.htm
**Add £2 per order for UK post and packing. Make cheques payable to EPT Educational Software.**

**Visa and Mastercard** orders accepted – please give card number, expiry date and cardholders address if different from the delivery address.
**OVERSEAS ORDERS:** Add £2.50 postage for countries in the E.E.C. Overseas readers, **outside the E.E.C. countries** add £3.50 for airmail postage.

## £1 BARGAIN PACKS
## – List 5

If you would like to receive the other four £1 lists and a lot of other lists, request these when you order or send SAE.

**TEST PRODS FOR MULTIMETERS** with 4mm sockets. Good length very flexible lead, Ref: D86.

**8 OHM PM SPEAKERS,** size 8″ x 4″, pack of two. These may be lightly rusty and that is why they are so cheap but are electrically OK, Ref: D102.

**PAXOLIN PANELS,** size 6″ x 6″, approximately 1/16″ thick, pack of two, Ref: D103.

**13A SOCKET,** virtually unbreakable, ideal for trailing lead, Ref: D95.

**PIEZO BUZZER** with electronic sounder circuit, 3V to 9V D.C. operated, Ref: D76.

**DITTO** but without internal electronics, pack of two, Ref: D75.

**LUMINOUS ROCKER SWITCH,** approximately 30mm sq, pack of two, Ref: D64.

**ROTARY SWITCH,** 9-pole 6-way, small size and 1/4″ spindle, pack of two, Ref: D54.

**FERRITE RODS,** 7″ with coils for Long and Medium waves, pack of two, Ref: D52.

**DITTO** but without the coils, pack of three, Ref: D52.

**SLIDE SWITCHES,** SPDT, pack of 20, Ref: D50.

**MAINS DP ROTARY SWITCH** with 1/4″ control spindle, pack of five, Ref: D49.

**ELECTROLYTIC CAP,** 800µF at 6·4V, pack of 20, Ref: D48.

**ELECTROLYTIC CAP,** 1000µF + 1000µF 12V, pack of 10. Ref: D47.

**MINI RELAY** with 5V coil, size only 26mm x 19mm x 1mm, has two sets of changeover contacts, Ref: D42.

**MAINS SUPPRESSOR CAPS** 0·1µF 250V A.C., pack of 10, Ref: 1050.

**TELESCOPIC AERIAL,** chrome plated, extendable and folds over for improved F.M. reception, Ref: 1051.

**MES LAMP HOLDERS,** slide on to 1/4″ tag, pack of 10, Ref: 1054.

**PAXOLIN TUBING,** 1/4″ internal diameter, pack of two, 12″ lengths, Ref: 1056.

**ULTRA THIN DRILLS,** 0·4mm, pack of 10, Ref: 1042.

**20A TOGGLE SWITCHES,** centre off, part spring controlled, will stay on when pushed up but will spring back when pushed down, pack of two, Ref: 1043.

**HALL EFFECT DEVICES,** mounted on small heatsink, pack of two, Ref: 1022.

**12V POLARISED RELAY,** two changeover contacts, Ref: 1032.

**PAXOLIN PANEL,** 12″ x 12″ 1/16″ thick, Ref: 1033.

**MINI POTTED TRANSFORMER,** only 1·5VA 15V-0V-15V or 30V, Ref: 964.

**ELECTROLYTIC CAP,** 32µF at 350V and 50µF section at 25V, in aluminium can for upright mounting, pack of two, Ref: 995.

**PRE-SET POTS,** one megohm, pack of five, Ref: 998.

**WHITE PROJECT BOX** with rocker switch in top left-hand side, size 78mm x 115mm x 35mm, unprinted, Ref: 1006.

**6V SOLENOID,** good strong pull but quite small, pack of two, Ref: 1012.

**FIGURE-8 MAINS FLEX,** also makes good speaker lead, 15m, Ref: 1014.

**HIGH CURRENT RELAY,** 24V A.C. or 12V D.C., three changeover contacts, Ref: 1016.

**LOUDSPEAKER,** 8 Ohm 5W, 3·7″ round, Ref: 962.

**NEON PILOT LIGHTS,** oblong for front panel mounting, with internal resistor for normal mains operation, pack of four, Ref: 970.

**3·5MM JACK PLUGS,** pack of 10, Ref: 975.

**WANDER PLUGS,** pack of 10, Ref: 986.

**PSU,** mains operated, two outputs, one 9·5V at 550mA and the other 15V at 150mA, Ref: 988.

**ANOTHER PSU,** mains operated, output 15V A.C. at 320mA, Ref: 989.

**PHOTOCELLS,** silicon chip type, pack of four, Ref: 939.

**LOUDSPEAKER,** 5″ 4 Ohm 5W rating, Ref: 946.

**230V ROD ELEMENTS,** 500W terminal-ended, 10″ long, pack of two, Ref: 943.

**LOUDSPEAKER,** 7″ x 5″ 4 Ohm 5W, Ref: 949.

**LOUDSPEAKER,** 4″ circular 6 Ohm 3W, pack of 2, Ref: 951.

**FERRITE POT CORES,** 30mm x 15mm x 25mm, matching pair, Ref: 901.

**PAXOLIN PANEL,** 8½″ x 3½″ with electrolytics 250µF and 100µF, Ref: 905.

**CAR SOCKET PLUG** with P.C.B. compartment, Ref: 917.

**FOUR-CORE FLEX** suitable for telephone extensions, 10m, Ref: 918.

**VERO OFF-CUTS,** approximately 30 square inches of useful sizes, Ref: 927.

**PROJECT CASE,** 95mm x 66mm x 23mm with removable lid, held by four screws, pack of two, Ref: 876.

**SOLENOIDS,** 12V to 24V, will push or pull, pack of two, Ref: 877.

**2M MAINS LEAD,** 3-core with instrument plug moulded on, Ref: 879.

**TELESCOPIC AERIAL,** chrome plated, extendable, pack of two, Ref: 884.

**MICROPHONE,** dynamic with normal body for hand holding, Ref: 885.

**CROCODILE CLIPS,** superior quality flex, can be attached without soldering, five each red and black, Ref: 886.

**BATTERY CONNECTOR FOR PP3,** superior quality, pack of four, Ref: 887.

**LIGHTWEIGHT STEREO HEADPHONES,** Ref: 898.

**PRESETS,** 470 Ohm and 220 kilohm, mounted on single panel, pack of 10, Ref: 849.

**THERMOSTAT** for ovens with 1/4″ spindle to take control knob, Ref: 857.

**12V-0V-12V 10W MAINS TRANSFORMER,** Ref: 811.

**18V-0V-18V 10W MAINS TRANSFORMER,** Ref: 813.

**AIR-SPACED TRIMMER CAPS,** 2pF to 20pF, pack of two, Ref: 818.

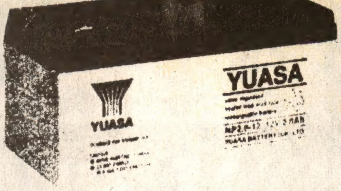
**AMPLIFIER,** 9V or 12V operated Mullard 1153, Ref: 823.

**2 CIRCUIT MICROSWITCHES,** licon, pack of 4, Ref: 825.

**LARGE SIZE MICROSWITCHES** (20mm x 6mm x 10mm) changeover contacts, pack of two, Ref: 826.

**MAINS VOLTAGE PUSHSWITCH** with white dolly, through panel mounting by hexagonal nut, Ref: 829.

**POINTER KNOB** for spindle which is just under 1/4″, like most thermostats, pack of four, Ref: 833.



## MAINTENANCE FREE BATTERIES

**The YUASA batteries** are sealed lead-acid types and they can be used in any position and are virtually maintenance free. We have two popular ones in stock at bargain prices, the 12V 15AH will cost you only **£10,** Order Ref. 10P140. This battery would also stand in as a car battery in an emergency.

The other one we have is much smaller, it is a 12V 2·3AH, regular price £14, yours for **£5**, Order Ref. 5P258. These batteries are in tip top condition, virtually unused and fully guaranteed.

**DRY BATTERIES** All high wattage, heavy duty type. Four popular types in stock:-

1½V HP7, sometimes known as the penlight battery, four for **60p,** Order Ref: GT10.

1½V HP2, sometimes known as the big torch battery, two for **60p,** Order Ref: GT11.

1½V HP11, also a popular torch battery, two for **50p,** Order Ref: GT12.

9V, ever popular PP3, 2 for **£1,**Order Ref:GT13.

**35mm PANORAMIC CAMERA.** Has super wide lens, ideal for holiday viewing, is focus free and has an extra bright and clear view finder. Brand new and guaranteed, individually boxed, **£6.50,** Order Ref: 6.5P2.

**0V-20V D.C. PANEL METER.** This is a nice size, 65mm sq. It is ideal if you are making a voltage variable instrument or battery charger. Price **£3,** Order Ref: 3P188.

**FLASHING BEACON.** Ideal for putting on a van, a tractor or any vehicle that should always be seen. Uses a XENON tube and has an amber coloured dome. Separate fixing base is included so unit can be put away if desirable. Price **£7.50,** Order Ref:7.5P13.

### BIG BUYER

Please note if you order 10 of an item you may deduct 10%. If you order 25, then deduct 25% but add VAT. If you need 100 or more, you can usually deduct 40% but please ring to confirm.

**12V 2A TRANSFORMER, £2,** Order Ref: 2P337.

**12V-0V-12V TRANSFORMER,** 35VA, **£2.50,** Order Ref: 2.5P13.

**HIGH RESOLUTION MONITOR.** 9″ by Philips, in metal frame for easy mounting. Brand new, offered at less than the price of the tube alone, **£15,** Order Ref: 15P1.

**15W 8″ 8 OHM SPEAKER AND 3″ TWEETER.** Amstrad, made for their high quality music centre, **£4** per pair, Order Ref: 4P57.

**INSULATION TESTER WITH MULTIMETER.** Internally generates voltages which enables you to read insulation directly in Megohms. The multimeter has four ranges: A.C./D.C. volts; 3 ranges milliamps; 3 ranges resistance and 5 amp range. Ex-British Telecom, tested and guaranteed OK, yours for only **£7.50** with leads, carrying case **£2** extra, Order Ref: 7.5P4.

We have some of the above testers not working on all ranges, should be repairable, we supply diagram, **£3,** Order Ref: 3P176.

**LCD 3½ DIGIT PANEL METER.** This is a multi-range voltmeter/ammeter using the A-D converter chip 7106 to provide five ranges each of volts and amps. Supplied with full data sheet. Special snip price of **£12,** Order Ref: 12P19.

**MINI BLOW HEATER.** 1kW, ideal for under desk or airing cupboard, etc. Needs only a simple mounting frame, **£5,** Order Ref: 5P23.

**MEDICINE CUPBOARD ALARM.** Or it could be used to warn when any cupboard door is opened. The light shining on the unit makes the bell ring. Completely built and neatly cased, requires only a battery, **£3.** Order Ref: 3P155.

**DON'T LET IT OVERFLOW!** Be it bath, sink, cellar, sump or any other thing that could flood. This device will tell you when the water has risen to the pre-set level. Adjustable over quite a useful range. Neatly cased for wall mounting, ready to work when battery fitted, **£3.** Order Ref: 3P156.

## £1.50 BARGAIN PACKS

**NiCad BATTERY** 3·6V with P.C.B. mounting prongs, Order Ref: 1.5P2.

**6-DIGIT COUNTER** 12V, Order Ref: 1.5P3.

**PAIR OF ULTRASONIC MODULES,** one sender, one receiver, Order Ref: 1.5P4.

**100-CORE CABLE,** any length, Order Ref: 1.5P6 per metre.

**KEY SWITCH,** two-position, complete with two Yale type keys, Order Ref: 1.5P12.

**CASSETTE MOTOR,** 9V brushless, Order Ref: 1.5P14.

**80 OHM COAX TV CABLE,** extra thin, 10m, Order Ref: 1.5P17.

**WATERPROOF SPEAKER,** 3½" round, 8 Ohm 11W, Order Ref: 1.5P27.

**6V 1A ENCASED POWER SUPPLY** with input and output leads, Order Ref: 1.5P22.

**FLUORESCENT CHOKE** for 60W or 80W tube, Order Ref: 1.5P23.

**3" TWEETER** 8 Ohms 15W, Order Ref: 1.5P28.

**13A SWITCH SOCKET,** white, Order Ref: 1.5P29.

**RELAY,** flash-proof, 12V coil, SPCO, Order Ref: 1.5P31.

**ENCASED PSU,** twin outputs, 15V 850mA and 9V 550mA, both A.C. output, Order Ref: 1.5P32.

**12V MOTOR,** mini but quite powerful, 32mm diameter, 25mm long, Order Ref: 1.5P33.

## £2 BARGAIN PACKS

**20W TWEETER** 4" x 4" 8 Ohm by Goodmans, Order Ref: 2P403.

**MOVING COIL CHARGE METER,** 0-3A, Order Ref: 2P366.

**LIGHT-OPERATED SWITCH,** kit of parts, Order Ref: 2P369.

**W-SHAPED 30W FLUORESCENT TUBE** by Philips. Ideal name plate illuminator, Order Ref: 2P372.

**DIMMER SWITCH,** standard size plate, colours – red, yellow, green, blue. Order Ref: 2P380.

**TOROIDAL TRANSFORMER** 7V 5A, Order Ref: 2P390.

**TELEPHONE EXTENSION LEAD,** flat plug one end, socket the other, 12m, Order Ref: 2P338.

**INTERNAL TELEPHONE EXTENSION,** 4-core cable, 25m, Order Ref: 2P339.

**FIGURE-8 FLEX,** mains voltage, 50m, Order Ref: 2P345.

**INFRA-RED RECEIVER,** has fitted TV receiver, Order Ref: 2P304.

**LCD CLOCK MODULE** with details on other uses, Order Ref: 2P307.

**AM/FM RADIO RECEIVER** with speaker and dial bul not cased, Order Ref: 2P308.

**12V 200mA PSU on 13A base,** Order Ref: 2P313.

**2A MAINS FILTER AND PEAK SUPPRESSOR,** Order Ref: 2P315.

**45A DP 250V SWITCH** on 6" x 3" gold plate, Order Ref: 2P316.

**D.C. VOLT REDUCER,** 12V-6V, fits into car lighter socket, Order Ref: 2P318.

**SOLAR CELL 3V,** five of these in series would make you a 12V battery charger, £2 each, Order Ref: 2P374,

**PERMANENT MAGNET SOLENOID,** opposite action, core is released when voltage is applied, Order Ref: 2P327.

**HEATER PAD,** not waterproof, Order Ref: 2P329.

**DISK DRIVE,** complete less stepper motor, has all the electronics to control stepper motor, Order Ref: 2P280.

**15V 320mA A.C. POWER SUPPLY,** in case with 13A base, ideal for bell or chime controller, Order Ref: 2P281.

**POWERFUL MAINS MOTOR** with 4″ spindle, Order Ref: 2P262.

**20M 80 OHM TV COAX,** Order Ref: 2P270.

**LOCTITE METAL ADHESIVE,** tube and some accessories, Order Ref: 2P215.

**6-DIGIT COUNTER,** mains operated, Order Ref: 2P235.

**2-GANG 0·0005 TUNING CAPACITOR,** standard size, made by Jacksons, Order Ref: 2P240.

**13A ADAPTORS,** takes two 13A plugs, pack of 5 – £2, Order Ref: 2P187.

**3-CORE 5A PVC FLEX,** 15m, Order Ref: 2P189.

**MAINS TRANSFORMER,** 15V 1 A, Order Ref: 2P198.

**FLIP-OVER CLOCK,** mains operated, only requires a simple case, Order Ref: 2P205.

**THERMOSTAT** with calibrated knob, oven temperatures, Order Ref: 2P1 58.

**7-SEGMENT NEON DISPLAYS,** pack of 8, Order Ref: 2P126.

**MODERN TELEPHONE HANDSET,** ideal office extension, Order Ref: 2P94.

**13A SWITCH SOCKET** on satin chrome plate, Order Ref: 2P95.

**500 STAPLES,** hardened pin, suit burglar alarm or telephone wire, Order Ref: 2P99.

**PAD SWITCH** for under carpets, Order Ref: 2P119.

**6½" FAN AND MAINS MOTOR,** Order Ref: 2P64.

**24V STEREO POWER SUPPLY,** Mullard, Order Ref: 2P80.

**UP TO 90 MIN 25A SWITCH,** clockwork, Order Ref: 2P90.

**UNI-SELECTOR,** 25-way, 3-pole, Order Ref: 2P53.

**POWERFUL MAINS MOTOR,** 1½" stack, double spindle, Order Ref: 2P55.

**POWER SUPPLY FOR MODELS,** 6V to 12V variable and reversible, Order Ref: 2P3.

**MAINS TO 115V AUTO TRANSFORMER** 10OW, ex-GPO, Order Ref: 2P6.

**MAINS TIME AND SET SWITCH** 25A, up to nine hours delay, Order Ref: 2P9.

**MOTORISED SIX MICROSWITCHES** but motor 50V A.C., Order Ref: 2P19.

**TWIN EXTENSION LEAD,** ideal lead lamp, Black & Decker tools, etc, 20m. Order Ref: 2P20.

**MAINS COUNTER,** resettable, 3 digit, Order Ref: 2P26.

---

**Prices include VAT and carriage cost if order over £25 otherwise add £3. Send cash, uncrossed postal orders, cheque or quote credit card number.**

## J & N FACTORS

**Pilgrim Works (Dept. E.E.)**
**Stairbridge Lane, Bolney,**
**Sussex RH17 5PA**
**Telephone: 01444 881965**
**(Also fax but phone first)**

# SURVEILLANCE
## PROFESSIONAL QUALITY KITS

# No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

**Genuine SUMA kits available only direct from Suma Designs. Beware inferior imitations!**

**UTX Ultra-miniature Room Transmitter**
Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3-12V operation. 500m range.......£16.45

**MTX Micro-miniature Room Transmitter**
Best-selling micro-miniature Room Transmitter
Just 17mm x 17mm including mic. 3-12V operation. 1000m range.......£13.45

**STX High-performance Room Transmitter**
Hi performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm including mic. 6-12V operation, 1500m range.......£15.45

**VT500 High-power Room Transmitter**
Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9-12V operation. 3000m range.......£16.45

**VXT Voice Activated Transmitter**
Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range...£19.45

**HVX400 Mains Powered Room Transmitter**
Connects directly to 240V AC supply for long-term monitoring. Size 30mm x 35mm. 500m range.......£19.45

**SCRX Subcarrier Scrambled Room Transmitter**
Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range.......£22.95

**SCLX Subcarrier Telephone Transmitter**
Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range.......£23.95

**SCDM Subcarrier Decoder Unit for SCRX**
Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9-12V operation.......£22.95

**ATR2 Micro Size Telephone Recording Interface**
Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line.......£13.45

## ★★★ Specials ★★★

**DLTX/DLRX Radio Control Switch**
Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way dil switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.
Complete System (2 kits).......£50.95
Individual Transmitter DLTX.......£19.95
Individual Receiver DLRX.......£37.95

**MBX-1 Hi-Fi Micro Broadcaster**
Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle. Size 27mm x 60mm. 9V operation. 250m range.......£20.95

**UTLX Ultra-miniature Telephone Transmitter**
Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use.
All conversation transmitted. Powered from line. 500m range.......£15.95

**TLX700 Micro-miniature Telephone Transmitter**
Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range.......£13.45

**STLX High-performance Telephone Transmitter**
High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm.
1500m range.......£16.45

**TKX900 Signalling/Tracking Transmitter**
Transmits a continous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation.......£22.95

**CD400 Pocket Bug Detector/Locator**
LED and piezo bleeper pulse slowly, rate of pulse and pitch of tome increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation.......£30.95

**CD600 Professional Bug Detector/Locator**
Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation.......£50.95

**QTX180 Crystal Controlled Room Transmitter**
Narrow band FM transmitter for the ultimate in privacy. Operates on 180 MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue). Size 20mm x 67mm. 9V operation. 1000m range.......£40.95

**QLX180 Crystal Controlled Telephone Transmitter**
As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range.......£40.95

**QSX180 Line Powered Crystal Controlled Phone Transmitter**
As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m.......£35.95

**QRX180 Crystal Controlled FM Receiver**
For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as a pre-built and aligned module ready to connect on board so no difficulty setting up. Outpt to headphones. 60mm x 75mm. 9V operation.......£60.95

**A build-up service is available on all our kits if required.**

UK customers please send cheques, POs or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft and add £5.00 per order for shipment. Credit card orders welcomed on 0827 714476.

**OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.**

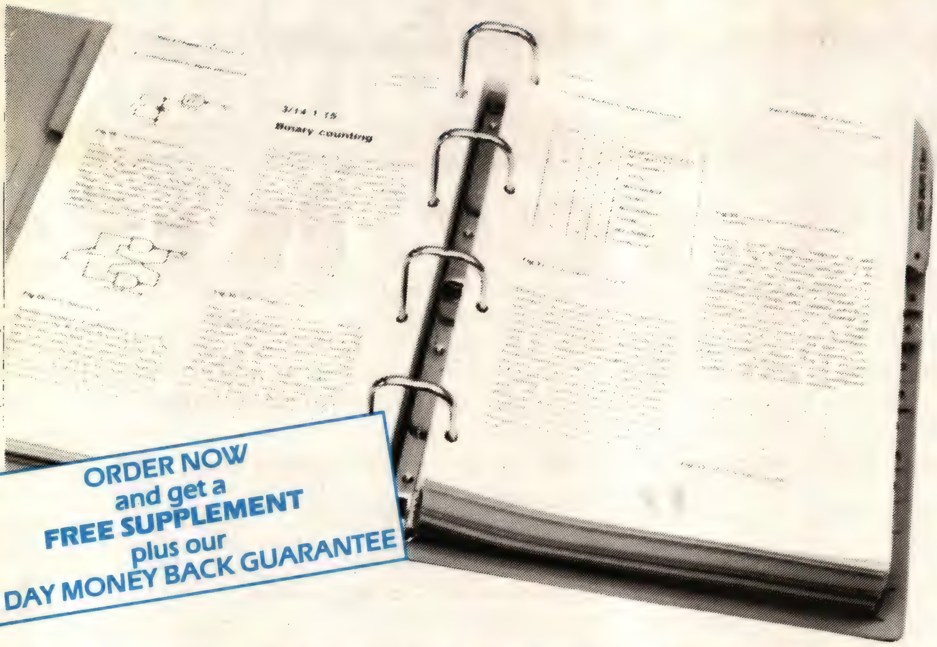
**SUMA DESIGNS**

DEPT. EE
THE WORKSHOPS, 95 MAIN ROAD,
BAXTERLEY. NEAR ATHERSTONE,
WARWICKSHIRE CV9 2LE

VISITORS STRICTLY BY APPOINTMENT ONLY

☎ Tel/Fax:
01827 714476

# LEARN ALL ABOUT ELECTRONICS



ORDER NOW
and get a
FREE SUPPLEMENT
plus our
30 DAY MONEY BACK GUARANTEE

## The essential reference work

- Easy-to-use format
- Clear and simple layout
- Comprehensive subject range
- Regular Supplements
- Sturdy ring-binder
- Projects to build
- Components checklists
- Extensive data tables
- Detailed supply information
- Ready-to-transfer PCBs
- Detailed assembly instructions
- Professionally written

### The revised edition of The Modern Electronics Base Manual contains practical, easy-to-follow information on the following subjects:

**BASIC PRINCIPLES:** Symbols, components and their characteristics, active and passive component circuits, power supplies, acoustics and electroacoustics, the workshop, principles of metrology, measuring instruments, digital electronics, analogue electronics, physics for electronics.

**CIRCUITS TO BUILD:** From basic principles to circuit-building, The Modern Electronics Manual and its Supplements describe how to assemble radios, loudspeakers, amplifiers, car projects, computer interfaces, measuring instruments, workshop equipment, security systems, etc.

### GUARANTEE

Our 30 day money back guarantee gives you **complete peace of mind.** If you are not entirely happy with the Manual, for whatever reason, simply return it to us in good condition within 30 days and we will make **a full refund of your payment** – no small print and no questions asked.
(Overseas buyers do have to pay the postage charge)

**ESSENTIAL DATA:** Extensive tables on diodes, transistors, thyristors and triacs, digital and linear i.c.s, microprocessors.

The Manual also has an extensive **Glossary,** and covers **Safety, Specialist Vocabulary with Abbreviations** and **Suppliers.** The most comprehensive reference work ever produced at a price you can afford, the revised edition of **THE MODERN ELECTRONICS MANUAL** provides you with all the essential information you need.

OVER 1,000 A4 loose leaf pages in a sturdy ring binder all for just **£39.95** plus **£6.00** post and packing. Regular Supplements continuously extend the Manual with new material, each Supplement contains approximately 160 pages of information. These and sent about five times a year and cost **£23.50** plus **£2.50** p&p. You can of course return any Supplement (within 10 days) or cancel the Supplements at any time.

**Wimborne Publishing Ltd., Dept. Y3**
**Allen House, East Borough,**
**Wimborne,**
**Dorset BH21 1PF**
**Tel: 01202 881749 Fax: 01202 841692**

## PLEASE

send me **THE MODERN ELECTRONICS MANUAL** plus a **FREE SUPPLEMENT.**

I enclose payment of **£45.95.** I shall also receive the appropriate supplements several times a year. These are billed separately and can be discontinued at any time. Should I decide not to keep the Manual I will return it to you within 30 days for a full refund.

### ORDER FORM

Simply complete and return the order form with your payment to the following address:

**Wimborne Publishing Ltd, Dept. Y3**
**Allen House, East Borough, Wimborne,**
**Dorset BH21 1PF**

**FULL NAME** ..........................................................................
**(PLEASE PRINT)**

**ADDRESS**..........................................................................

..........................................................................

.................................................. **POSTCODE** ..........................

**SIGNATURE**..........................................................................

☐ **I enclose cheque/PO payable to Wimborne Publishing Ltd.**

☐ **Please charge my Visa/Mastercard/Access**

**Card No.** .................................................. **Card Ex. Date** ............

**OVERSEAS ORDERS:** All overseas orders **must be prepaid** and are supplied under a money-back guarantee of satisfaction. If you are not entirely happy with the Manual return it within a month for a refund of the purchase price (you do have to pay the overseas postage). **SEND £39.95 PLUS THE POSTAGE SHOWN BELOW:**

| | | |
|---|---|---|
| EIRE | | AIR MAIL ONLY **£11** |
| EUROPE (E.E.C. Countries) | | AIR MAIL ONLY **£20** |
| EUROPE (non E.E.C.) | SURFACE MAIL **£20**, | AIR MAIL **£26** |
| U.S.A. & CANADA | SURFACE MAIL **£25**, | AIR MAIL **£32** |
| FAR EAST & AUSTRALIA | SURFACE MAIL **£31**, | AIR MAIL **£33** |
| REST OF WORLD | SURFACE MAIL **£25**, | AIR MAIL **£44** |

**Note** surface mail can take over 10 weeks to some parts of the world. Each manual weighs about 4kg including the free supplement when packed.

All payments must be made in £'s Sterling payable to Wimborne Publishing Ltd. We accept Mastercard (Access) and Visa credit cards.

# MAGENTA
ELECTRONICS LTD

135 Hunter Street
Burton-on-Trent
Staffs. DE14 2ST
Tel 01283 565435 Fax 546932 EE165

All Prices include V.A.T. Add £3.00 per order p &p

**MAIL ORDER ONLY • CALLERS BY APPOINTMENT**

## EPE MICROCONTROLLER P.I. TREASURE HUNTER

The latest MAGENTA DESIGN – highly stable & sensitive – with µC control of all timing functions and advanced pulse separation techniques.

- New circuit design 1994
- High stability drift cancelling
- Easy to build & use
- No ground effect, works in seawater
- Detects gold, silver, ferrous & non-ferrous metals
- Efficient quartz controlled microcontroller pulse generation.
- Full kit with headphones & all hardware

KIT 847........................£63.95

## DIGITAL LCD THERMOSTAT

A versatile thermostat using a thermistor probe and having an l.c.d. display. MIN/MAX memories, -10 to 110 degrees celsius, or can be set to read in Fahrenheit. Individually settable upper and lower switching temperatures allow close control, or alternatively allow a wide 'dead band' to be set which can result in substantial energy savings when used with domestic hot water systems. Ideal for greenhouse ventilation or heating control, aquaria, home brewing, etc. Mains powered, 10A SPCO relay output. Punched and printed case.

KIT 841.........................£29.95

## PORTABLE ULTRASONIC PEsT SCARER

A powerful 23kHz ultrasound generator in a compact hand-held case. MOSFET output drives a special sealed transducer with intense pulses via a special tuned transformer. Sweeping frequency output is designed to give maximum output without any special setting up.

KIT 842..........................£22.56

## DIGITAL CAPACITANCE METER

A really professional looking project. Kit is supplied with a punched and printed front panel, case, p.c.b. and all components. Quartz controlled accuracy of 1%. Large clear 5 digit display and high speed operation. Ideal for beginners – as the µF, hF and pF ranges give clear unambiguous read out of marked and unmarked capacitors from a few pF up to thousands of µF.

KIT 493..........................£39.95

## ACOUSTIC PROBE

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches, and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers, and nosey parkers!.

KIT 740..........................£19.98

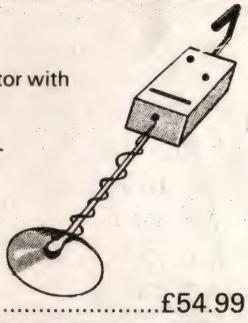
## WINDICATOR

A novel wind speed indicator with LED read-out. Kit comes complete with sensor cups, and weatherproof sensing head. Mainspower unit £5.99 extra.

KIT 856.............................................£28.00

## BUCCANEER I.B. METAL DETECTOR

An Induction Balance (I.B.) detector with audible output. Providing good sensititivy and easy construction.
COMPLETE KIT – INCLUDES ALL HARDWARE, HANDLE, SEARCH HEAD, PCB etc.
CIRCUIT REJECTS IRON WHILST PICKING UP GOLD, SILVER, COPPER etc.
A SOLID RELIABLE DESIGN.



KIT 719.......................................................£54.99

## 1000V & 500V INSULATION TESTER

Superb new design. Regulated output, efficient circuit. Dual-scale meter, compact case. Reads up to 200 Megohms.
Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848...................£32.95

## MOSFET MkII VARIABLE BENCH POWER SUPPLY 0-25V 2·5A.

Based on our MkI design and preserving all the features, but now with switching pre-regulator for much higher efficiency. Panel meters indicate Volts and Amps. Fully variable down to zero. Toroidal mains transformer. Kit includes punched and printed case and all parts. As featured in April 1994 *EPE*. An essential piece of equipment.

KIT 845............£64.95

## ULTRASONIC PEsT SCARER

Keep pets/pests away from newly sown areas, fruit, vegetable and flower beds, children's play areas, patios etc. This project produces intense pulses of ultrasound which deter visiting animals.

- KIT INCLUDES ALL COMPONENTS, PCB & CASE
- EFFICIENT 100V TRANSDUCER OUTPUT
- COMPLETELY INAUDIBLE TO HUMANS
- UP TO 4 METRES RANGE
- LOW CURRENT DRAIN

KIT 812......................................................£14.81

## SPACEWRITER

An innovative and exciting project. Wave the wand through the air and your message appears. Programmable to hold any message up to 16 digits long. Comes pre-loaded with "MERRY XMAS". Kit includes PCB, all components & tube + instructions for message loading.

KIT 849......................£16.99

## 12V EPROM ERASER

A safe low cost eraser for up to 4 EPROMS at a time in less than 20 minutes. Operates from a 12V supply (400mA). Used extensively for mobile work - updating equipment in the field etc. Also in educational situations where mains supplies are not allowed. Safety interlock prevents contact with UV.

KIT 790.........................£28.51

## MOSFET 25V 2.5A POWER SUPPLY

High performance design has made this one of our classic kits. Two panel meters indicate Volts and Amps. Variable from 0-25 Volts and current limit control from 0-2·5A. Rugged power MOSFET output stage. Toroidal mains transformer.

KIT 769..........................£56.82

## INSULATION TESTER

A reliable and neat electronic tester which checks insulation resistance of wiring and appliances etc., at 500 Volts. The unit is battery powered, simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. A very popular college project.

KIT 444..........................£22.37

## DIGITAL COMBINATION LOCK

Digital lock with 12 key keypad. Entering a four digit code operates a 250V 16A relay. A special anti-tamper circuit permits the relay board to be mounted remotely. Ideal car immobiliser, operates from 12V. Drilled case, brushed aluminium keypad.

KIT 840..........................£19.86

## E.E. TREASURE HUNTER P.I. METAL DETECTOR MKI

Magenta's highly developed & acclaimed design. Quartz crystal controlled circuit MOSFET coil drive. D.C. coupled amplification. Full kit includes PCB, handle, case & search coil.

- KIT INC. HEADPHONES
- EFFICIENT CMOS DESIGN
- POWERFUL COIL DRIVE
- DETECTS FERROUS AND NON-FERROUS METAL – GOLD, SILVER, COPPER ETC.
- 190mm SEARCH COIL
- NO 'GROUND EFFECT'

KIT 815..........................£45.95

## *Comstep PC Computer Interface and Driver board*

*Drives two motors from PC parallel port. Supplied with comprehensive software. Needs 12Volt 1A supply.*

With 2-200 Step Motors

***Kit 846....................£67.00***

## *Power Booster for Comstep*

*Adds to Comstep and allows motors up to 4 Amps to be driven. Two boosters drive two motors from a single Comstep. Uses standard Comstep software.*

With MD24 Motors

***Kit 850....................£39.95***

## EDUCATIONAL BOOK & PACK

**ADVENTURES WITH ELECTRONICS**

The classic book by Tom Duncan used throughout schools. Very well illustrated, ideal first book for age 10 on. No soldering. Uses an S.DEC breadboard.

**Book &Components.........................£28.95**
**Book only.......................................... £7.99**

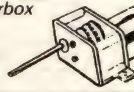
## *Versatile Stepping motor Interface*

*A Magenta design, gives Half and Full-Wave drive. Up to 1Amp and 24Volts. CMOS inputs – Drive from logic or computer port. Needs power supply.*

***Kit 816......................£9.82***

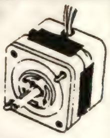
## *DC Motor/Gearboxes*

*Our Popular and Versatile DC motor/Gearbox sets. Ideal for Models, Robots, Buggies etc. 1·5 to 4·5V Multi ratio gearbox gives wide range of speeds.*



***LARGE TYPE – MGL £6.95***
***SMALL – MGS – £4.77***

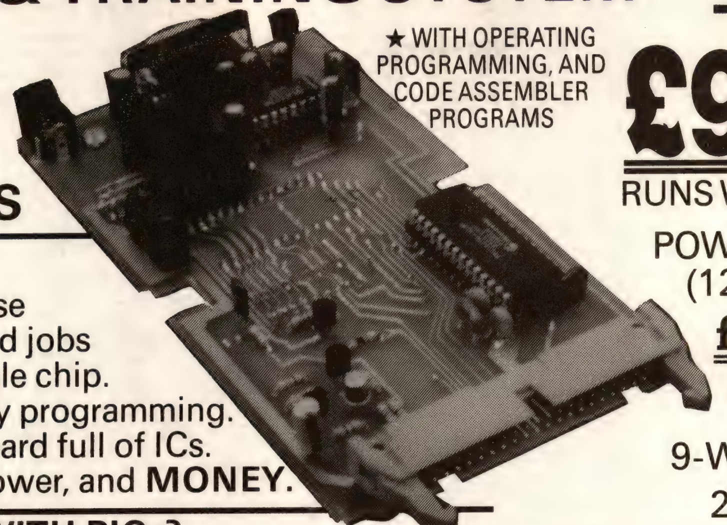
## *Stepping Motors*



**MD38...Mini 48 step...£8.65**
**MD35...Std 48 step...£12.98**
**MD200...200 step...£16.80**
**MD24...Large 200 step...£22.95**

# PIC DEVELOPMENT & TRAINING SYSTEM PIC

YOUR KEY
TO ANOTHER
NEW AGE OF
**ELECTRONICS**



★ WITH OPERATING PROGRAMMING, AND CODE ASSEMBLER PROGRAMS

**£99** INCLUDING VAT + £3.00 p&p

RUNS WITH ANY PC

POWER SUPPLY
(12V at 200mA)
**£8.99**

PC LEADS
9-WAY **£6.00**
25-WAY **£7.00**

**PICs** are being used more and more because they allow complicated jobs to be done with a single chip. All the work is done by programming. One PIC replaces a board full of ICs. Saving time, space, power, and **MONEY**.

### HOW DO I START WITH PICs?

**STEP 1** – Buy the PIC-DATS Development & Training System

**STEP 2** – Follow May & June '95 *EPE* Series – showing how to program for practical applications

**STEP 3** – Start writing and testing your own programs

### PIC PROJECT – LIGHT CONTROLLER DEVELOPMENT SYSTEM

A real-world application for a PIC microchip. This project can be made to do just what you chose by writing your own software. It can be programmed to work as a 4-Channel Light Chaser or a simple controller for domestic lighting. Zero volt crossing signal is provided and there is a 4x3 matrix keypad. (Less case).

**Kit 855........................................................£35.95**

## SIMPLE PIC16C84 PROGRAMMER

**NEW!**

Based on the design in February '96 EPE. Magenta have made a proper PCB for this circuit and a full kit of parts. The PCB eliminates the risk of layout errors. Additional contact points are provided to allow connection to RA and unused RB pins when testing programs. Kit includes 1 – PIC16C84 chip, lead, connector and all software.

Programmer Kit – with software disk, lead, connector and PIC16C84 chip, including PCB.
Kit 857..................................................£12.99

Power Supply Unit 12V-14V..................£3.99

Extra PIC16C84 Chips..........................£7.36

## BAT DETECTOR

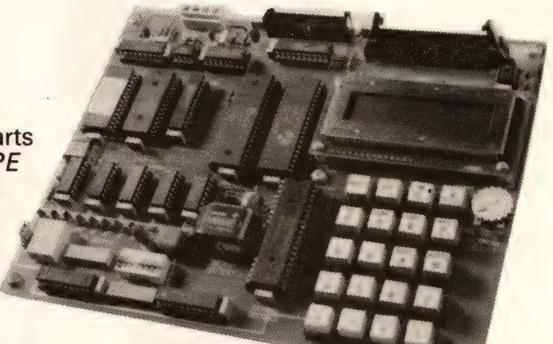
An excellent circuit which reduces ultrasound frequencies between 20 and 100 kHz to the normal (human) audible range. Operating rather like a radio receiver the circuit allows the listener to tune-in to the ultrasonic frequencies of interest. Listening to Bats is fascinating, and it is possible to identify various different types using this project. Other uses have been found in industry for vibration monitoring etc.

KIT 814......................£21.44

## *Mini-Lab & Micro Lab*

## Electronics Teach-In 7

As featured in *EPE* and now published as Teach-In 7. All parts are supplied by Magenta. *Teach-In 7* is £3.95 from us or *EPE*
Full Mini Lab Kit – £119.95 – Power supply extra – £22.55
Full Micro Lab Kit – £155.95 Built Micro Lab – £189.95



**MAGENTA**

**Tel: 01283 565435   Fax: 01283 546932**   All prices include VAT. Add **£3.00** p&p.

Tel (0191) 251 4363
Fax (0191) 252 2296
ELECTRONIC COMPONENTS
Station Road, Cullercoats,
Tyne & Wear
NE30 4PQ
U.K.
396

### 4000 Series

| | |
|---|---|
| 4000 | £0.17 |
| 4001 | £0.20 |
| 4002 | £0.17 |
| 4006 | £0.40 |
| 4007 | £0.18 |
| 4008 | £0.31 |
| 4009 | £0.19 |
| 4010 | £0.23 |
| 4011 | £0.20 |
| 4012 | £0.16 |
| 4013 | £0.24 |
| 4014 | £0.30 |
| 4015 | £0.24 |
| 4016 | £0.30 |
| 4017 | £0.31 |
| 4018 | £0.27 |
| 4019 | £0.48 |
| 4020 | £0.31 |
| 4021 | £0.31 |
| 4022 | £0.32 |
| 4023 | £0.16 |
| 4024 | £0.32 |
| 4025 | £0.15 |
| 4026 | £0.78 |
| 4027 | £0.26 |
| 4028 | £0.22 |
| 4029 | £0.40 |
| 4030 | £0.17 |
| 4031 | £0.70 |
| 4033 | £0.56 |
| 4034 | £1.24 |
| 4035 | £0.31 |
| 4040 | £0.38 |
| 4041 | £0.31 |
| 4042 | £0.22 |
| 4043 | £0.28 |
| 4044 | £0.35 |
| 4046 | £0.52 |
| 4047 | £0.48 |
| 4048 | £0.28 |
| 4049 | £0.22 |
| 4050 | £0.26 |
| 4051 | £0.43 |
| 4052 | £0.32 |
| 4053 | £0.40 |
| 4054 | £0.56 |
| 4055 | £0.34 |
| 4060 | £0.48 |
| 4063 | £0.29 |
| 4066 | £0.22 |
| 4067 | £1.96 |
| 4068 | £0.16 |
| 4069 | £0.20 |
| 4070 | £0.17 |
| 4071 | £0.22 |
| 4072 | £0.17 |
| 4073 | £0.17 |
| 4075 | £0.17 |
| 4076 | £0.30 |
| 4077 | £0.28 |
| 4078 | £0.20 |
| 4081 | £0.23 |
| 4082 | £0.21 |
| 4085 | £0.28 |
| 4086 | £0.26 |
| 4089 | £0.55 |
| 4093 | £0.22 |
| 4094 | £0.31 |
| 4095 | £0.56 |
| 4097 | £1.20 |
| 4098 | £0.48 |
| 4099 | £0.38 |
| 4502 | £0.38 |
| 4503 | £0.40 |
| 4508 | £1.40 |
| 4510 | £0.36 |
| 4511 | £0.56 |
| 4512 | £0.32 |
| 4514 | £0.77 |
| 4515 | £0.99 |
| 4516 | £0.31 |
| 4518 | £0.44 |
| 4520 | £0.43 |
| 4521 | £0.62 |
| 4526 | £0.40 |
| 4527 | £0.40 |
| 4528 | £0.40 |
| 4529 | £0.44 |
| 4532 | £0.32 |
| 4534 | £2.48 |
| 4536 | £1.00 |
| 4538 | £0.37 |
| 4541 | £0.33 |
| 4543 | £0.46 |
| 4555 | £0.34 |
| 4556 | £0.40 |
| 4560 | £1.18 |
| 4566 | £1.96 |
| 4572 | £0.25 |
| 4584 | £0.24 |
| 4585 | £0.47 |
| 4724 | £0.70 |
| 40106 | £0.37 |
| 40109 | £0.58 |
| 40163 | £0.46 |
| 40174 | £0.34 |
| 40175 | £0.36 |
| 40193 | £0.60 |

### 74HC Series

| | |
|---|---|
| 74HC00 | £0.16 |
| 74HC02 | £0.21 |
| 74HC03 | £0.21 |
| 74HC04 | £0.21 |
| 74HC08 | £0.21 |
| 74HC10 | £0.16 |
| 74HC11 | £0.20 |
| 74HC14 | £0.22 |
| 74HC20 | £0.28 |
| 74HC27 | £0.16 |
| 74HC30 | £0.22 |
| 74HC32 | £0.21 |
| 74HC42 | £0.25 |
| 74HC73 | £0.22 |
| 74HC74 | £0.23 |
| 74HC75 | £0.22 |
| 74HC76 | £0.20 |
| 74HC85 | £0.24 |
| 74HC86 | £0.22 |
| 74HC107 | £0.40 |
| 74HC123 | £0.33 |
| 74HC125 | £0.24 |
| 74HC126 | £0.46 |
| 74HC132 | £0.37 |
| 74HC133 | £0.29 |
| 74HC138 | £0.25 |
| 74HC139 | £0.31 |
| 74HC151 | £0.33 |
| 74HC153 | £0.27 |
| 74HC154 | £0.85 |
| 74HC157 | £0.40 |
| 74HC158 | £0.25 |
| 74HC160 | £0.32 |
| 74HC161 | £0.28 |
| 74HC162 | £0.45 |
| 74HC163 | £0.27 |
| 74HC164 | £0.35 |
| 74HC165 | £0.35 |
| 74HC173 | £0.32 |
| 74HC174 | £0.27 |
| 74HC175 | £0.27 |
| 74HC192 | £0.45 |
| 74HC195 | £0.32 |
| 74HC240 | £0.37 |
| 74HC241 | £0.37 |
| 74HC243 | £0.48 |
| 74HC244 | £0.42 |
| 74HC245 | £0.46 |
| 74HC251 | £0.25 |
| 74HC253 | £0.25 |
| 74HC257 | £0.25 |
| 74HC259 | £0.57 |
| 74HC273 | £0.35 |
| 74HC299 | £0.64 |
| 74HC356 | £0.45 |
| 74HC365 | £0.34 |
| 74HC367 | £0.25 |
| 74HC368 | £0.25 |
| 74HC373 | £0.35 |
| 74HC374 | £0.40 |
| 74HC390 | £0.52 |
| 74HC393 | £0.38 |
| 74HC423 | £0.37 |
| 74HC553 | £0.42 |
| 74HC563 | £0.48 |
| 74HC564 | £0.48 |
| 74HC573 | £0.45 |
| 74HC574 | £0.45 |
| 74HC640 | £0.73 |
| 74HC688 | £0.64 |
| 74HC4002 | £0.16 |
| 74HC4017 | £0.64 |
| 74HC4020 | £0.36 |
| 74HC4040 | £0.45 |
| 74HC4049 | £0.25 |
| 74HC4050 | £0.25 |
| 74HC4060 | £0.44 |
| 74HC4075 | £0.27 |
| 74HC4078 | £0.32 |
| 74HC4511 | £0.64 |
| 74HC4514 | £0.84 |
| 74HC4538 | £0.41 |
| 74HC4543 | £0.90 |

### 74LS Series

| | |
|---|---|
| 74LS00 | £0.20 |
| 74LS01 | £0.14 |
| 74LS02 | £0.29 |
| 74LS03 | £0.29 |
| 74LS04 | £0.21 |
| 74LS05 | £0.14 |
| 74LS07 | £0.32 |
| 74LS08 | £0.23 |
| 74LS09 | £0.14 |
| 74LS10 | £0.14 |
| 74LS11 | £0.17 |
| 74LS12 | £0.14 |
| 74LS13 | £0.14 |
| 74LS14 | £0.21 |
| 74LS15 | £0.14 |
| 74LS20 | £0.16 |
| 74LS21 | £0.14 |
| 74LS22 | £0.14 |
| 74LS26 | £0.14 |
| 74LS27 | £0.14 |
| 74LS30 | £0.20 |
| 74LS32 | £0.21 |
| 74LS37 | £0.14 |
| 74LS38 | £0.19 |
| 74LS40 | £0.14 |
| 74LS42 | £0.25 |
| 74LS47 | £0.72 |
| 74LS51 | £0.24 |
| 74LS73 | £0.40 |
| 74LS74 | £0.25 |
| 74LS75 | £0.19 |
| 74LS76 | £0.25 |
| 74LS83 | £0.31 |
| 74LS85 | £0.35 |
| 74LS86 | £0.20 |
| 74LS90 | £0.44 |
| 74LS92 | £0.35 |
| 74LS93 | £0.42 |
| 74LS107 | £0.23 |
| 74LS109 | £0.21 |
| 74LS112 | £0.24 |
| 74LS113 | £0.21 |
| 74LS114 | £0.21 |
| 74LS122 | £0.31 |
| 74LS123 | £0.31 |
| 74LS125 | £0.27 |
| 74LS126 | £0.25 |
| 74LS132 | £0.21 |
| 74LS133 | £0.36 |
| 74LS136 | £0.16 |
| 74LS138 | £0.40 |
| 74LS139 | £0.25 |
| 74LS145 | £0.56 |
| 74LS147 | £1.26 |
| 74LS148 | £0.70 |
| 74LS151 | £0.25 |
| 74LS153 | £0.25 |
| 74LS154 | £0.70 |
| 74LS155 | £0.25 |
| 74LS156 | £0.36 |
| 74LS157 | £0.22 |
| 74LS158 | £0.21 |
| 74LS160 | £0.48 |
| 74LS161 | £0.32 |
| 74LS162 | £0.44 |
| 74LS163 | £0.32 |
| 74LS164 | £0.24 |
| 74LS165 | £0.48 |
| 74LS170 | £0.30 |
| 74LS173 | £0.24 |
| 74LS174 | £0.24 |
| 74LS175 | £0.24 |
| 74LS190 | £0.60 |
| 74LS191 | £0.24 |
| 74LS192 | £0.60 |
| 74LS193 | £0.24 |
| 74LS195 | £0.24 |
| 74LS196 | £0.24 |
| 74LS197 | £0.24 |
| 74LS221 | £0.40 |
| 74LS240 | £0.32 |
| 74LS241 | £0.32 |
| 74LS242 | £0.32 |
| 74LS243 | £0.30 |
| 74LS244 | £0.32 |
| 74LS245 | £0.60 |
| 74LS247 | £0.32 |
| 74LS251 | £0.24 |
| 74LS257 | £0.24 |
| 74LS258 | £0.24 |
| 74LS266 | £0.14 |
| 74LS273 | £0.32 |
| 74LS279 | £0.25 |
| 74LS365 | £0.21 |
| 74LS367 | £0.21 |
| 74LS368 | £0.21 |
| 74LS373 | £0.33 |
| 74LS374 | £0.34 |
| 74LS375 | £0.34 |
| 74LS377 | £0.32 |
| 74LS378 | £0.62 |
| 74LS390 | £0.25 |
| 74LS393 | £0.24 |
| 74LS395 | £0.26 |
| 74LS399 | £0.62 |
| 74LS670 | £0.69 |

### Linear ICs

| | |
|---|---|
| AD524AD | £23.04 |
| AD548JN | £1.62 |
| AD590JH | £5.40 |
| AD592AN | £4.52 |
| AD595AQ | £14.64 |
| AD620AN | £9.88 |
| AD625JN | £16.20 |
| AD633JN | £8.25 |
| AD648JN | £2.57 |
| AD652AQ | £14.88 |
| AD654JN | £7.25 |
| AD698AP | £23.28 |
| AD707JN | £2.36 |
| AD708JN | £5.69 |
| AD711JN | £1.51 |
| AD712JN | £2.38 |
| AD736JN | £8.75 |
| AD795JN | £5.94 |
| AD797AN | £8.69 |
| AD811N | £6.73 |
| AD812AN | £6.32 |
| AD813AN | £8.81 |
| AD817AN | £3.85 |
| AD820AN | £3.24 |
| AD822AN | £5.20 |
| AD826AN | £5.33 |
| AD829JN | £6.41 |
| AD830AN | £6.14 |
| AD847JN | £6.50 |
| AD9696KN | £7.73 |
| ADEL2020AN | £5.06 |
| ADM222AH | £3.55 |
| ADM232AAN | £3.55 |
| ADM485JN | £2.97 |
| ADM690AN | £5.13 |
| ADM691AN | £6.48 |
| ADM695AN | £6.48 |
| ADM699AN | £3.58 |
| AMP04FP | £10.94 |
| BUF04GP | £8.56 |
| CA741CE | £0.26 |
| CA747CE | £0.39 |
| CA3046 | £0.37 |
| CA3059 | £1.16 |
| CA3080E | £0.73 |
| CA3130E | £0.98 |
| CA3140E | £0.56 |
| CA3189E | £1.22 |
| CA3240E | £1.12 |
| DG211CJ | £1.55 |
| DG212CJ | £1.55 |
| DG411DJ | £3.11 |
| DG412DJ | £4.19 |
| EL2020CN | £4.99 |
| EL2030CN | £5.67 |
| ICL7106 | £2.80 |
| ICL7611DCPA | £1.06 |
| ICL7621 | £1.70 |
| ICL8038 | £5.25 |
| ICM7555 | £0.36 |
| ICM7556 | £0.98 |
| L165V | £2.63 |
| L272M | £1.89 |
| L297 | £6.37 |
| L298 | £6.99 |
| LF347N | £0.86 |
| LF351N | £0.43 |
| LF353N | £0.42 |
| LF356 | £0.84 |
| LM301A | £0.25 |
| LM308N | £0.58 |
| LM311N-8 | £0.32 |
| LM318 | £1.28 |
| LM319N-14 | £0.96 |
| LM324 | £0.30 |
| LM335Z | £1.52 |
| LM339N | £0.24 |
| LM348N | £0.31 |
| LM358N | £0.27 |
| LM377 | £2.57 |
| LM380N-14 | £1.12 |
| LM381N | £2.64 |
| LM382 | £2.30 |
| LM386 | £0.79 |
| LM387 | £1.60 |
| LM392N | £0.79 |
| LM393N | £0.21 |
| LM709T | £0.79 |
| LM733 | £1.04 |
| LM748CN-8 | £0.31 |
| LM579CP | £3.38 |
| LM1458 | £0.37 |
| LM1881 | £5.22 |
| LM2917N8 | £3.20 |
| LM3900N | £0.72 |
| LM3909N | £1.76 |
| LM3911 | £2.56 |
| LM3914 | £2.70 |
| LM3915 | £2.70 |
| LM13600 | £1.82 |
| LMC660CN | £2.16 |
| LMC6032IN | £1.55 |
| LMC6042IN | £1.82 |
| LP311N | £0.74 |
| LP324N | £0.74 |
| LP339N | £0.73 |
| MAX202CPE | £2.97 |
| MAX208CNG | £6.99 |
| MAX220CPE | £5.06 |
| MAX222CPE | £5.06 |
| MAX232CPE | £2.16 |
| MAX238CNG | £6.88 |
| MAX242CPE | £5.51 |
| MAX631ACP | £4.99 |
| MAX635ACP | £4.99 |
| MC1488 | £0.39 |
| MC1489 | £0.39 |
| MC3302 | £0.56 |
| MC3340P | £1.60 |
| MC4558P | £0.36 |
| MV500DP | £2.63 |
| MV601DP | £2.97 |
| NE531 | £1.47 |
| NE555N | £0.25 |
| NE556N | £0.36 |
| NE565 | £1.84 |
| NE566N | £0.90 |
| NE567N | £0.39 |
| NE571N | £2.47 |
| NE592 | £0.62 |
| NE5532N | £0.80 |
| NE5534N | £0.64 |
| OP07CN | £1.42 |
| OP27CN | £2.90 |
| OP77GP | £2.36 |
| OP90GP | £3.11 |
| OP97FP | £2.43 |
| OP113GP | £3.44 |
| OP176GP | £2.09 |
| OP177GP | £1.89 |
| OP183GP | £3.44 |
| OP200GP | £5.60 |
| OP213FP | £5.20 |
| OP275GP | £2.57 |
| OP282GP | £2.27 |
| OP283GP | £5.20 |
| OP290GP | £5.40 |
| OP295GP | £4.73 |
| OP297GP | £5.74 |
| OP400GP | £11.81 |
| OP467GP | £13.74 |
| OP495GP | £8.69 |
| PM1012GP | £5.20 |
| RC4136 | £1.00 |
| SAA1027 | £4.46 |
| SG3524N | £1.08 |
| SG3543 | £6.88 |
| SL486 | £4.12 |
| SL490 | £4.05 |
| SSM2017P | £3.38 |
| SSM2131P | £4.19 |
| SSM2141P | £4.21 |
| SSM2142P | £6.40 |
| SSM2143P | £3.78 |
| TBA120S | £0.90 |
| TBA800 | £0.70 |
| TBA810S | £0.64 |
| TBA820M | £0.39 |
| TDA1024 | £1.49 |
| TDA1170S | £1.83 |
| TDA2002 | £1.04 |
| TDA2004 | £3.11 |
| TDA2030 | £1.18 |
| TDA2050V | £3.98 |
| TEA5115 | £3.11 |
| TL061CP | £0.35 |
| TL062CP | £0.60 |
| TL064CN | £0.72 |
| TL071CP | £0.48 |
| TL072CP | £0.50 |
| TL074CN | £0.58 |
| TL081 | £0.33 |
| TL082CP | £0.54 |
| TL084CN | £0.63 |
| TL494CN | £1.49 |
| TL7705ACP | £1.62 |
| TLC271 | £0.54 |
| TLC272 | £0.88 |
| TMP01FP | £5.60 |
| UA2240CN | £2.30 |
| ULN2003 | £0.52 |
| ULN2004A | £0.48 |
| ULN2608 | £1.20 |
| ULN2803 | £0.90 |
| ZN409CE | £1.89 |
| ZN414Z | £1.16 |
| ZN416E | £1.99 |
| ZN1034E | £3.11 |

### EPROM's

| | |
|---|---|
| 2716 | £4.46 |
| 2732 | £4.84 |
| 2764-25 | £4.20 |
| 27C64-25 | £3.44 |
| 27C010 | £5.74 |
| 27128-20 | £4.08 |
| 27C128-20 | £4.08 |
| 27256-20 | £4.85 |
| 27C256-20 | £3.68 |
| 27C512 | £3.42 |

### RAM

| | |
|---|---|
| 4164-15 | £1.78 |
| 6116-10 | £1.53 |
| 6264-10 | £3.16 |
| 41256-10 | £2.80 |
| 62256-10 | £5.35 |
| 511000-8 | £8.54 |
| 514256-8 | £6.88 |

### A/D Converters Data Acquisition

| | |
|---|---|
| AD420AN | £25.38 |
| AD557JN | £8.75 |
| AD574AJN | £18.48 |
| AD767JN | £20.88 |
| AD775JN | £18.48 |
| AD7226KN | £25.69 |
| AD7528JN | £8.63 |
| AD7545AKN | £14.04 |
| AD7581JN | £25.80 |
| AD7828KN | £20.33 |
| AD7845JN | £14.04 |
| ICL7109CPL | £7.75 |
| TLC549IP | £3.51 |
| ZN425E | £5.94 |
| ZN426E | £3.13 |
| ZN427E | £8.78 |
| ZN428E | £5.94 |
| ZN439E8 | £7.13 |
| ZN448E | £7.02 |

### Voltage Regulators

| | |
|---|---|
| 7805 | £0.44 |
| 7808 | £0.50 |
| 7812 | £0.43 |
| 7815 | £0.38 |
| 7905 | £0.40 |
| 7912 | £0.38 |
| 7915 | £0.38 |
| 7924 | £0.38 |
| 78L05 | £0.27 |
| 78L08 | £0.23 |
| 78L12 | £0.23 |
| 78L15 | £0.24 |
| 78L24 | £0.39 |
| 79L05 | £0.28 |
| 79L08 | £0.28 |
| 79L12 | £0.28 |
| 79L15 | £0.28 |
| 79L24 | £0.30 |
| ADM666AN | £3.44 |
| L200CV | £1.24 |
| L296 | £8.13 |
| L387A | £3.24 |
| LM2904CT | £2.30 |
| LM317T | £0.58 |
| LM323K | £2.84 |
| LM334Z | £1.35 |
| LM338K | £5.52 |
| LM723 | £0.29 |
| LP2950CZ | £2.97 |
| REF01CP | £3.44 |
| REF02CP | £4.66 |
| REF12Z | £1.28 |
| REF195GP | £4.72 |
| REF25Z | £1.24 |
| REF50Z | £1.22 |
| TL431CP | £0.45 |
| ZN423 | £1.55 |
| ZN458B | £1.89 |

### Diodes

| | |
|---|---|
| 1N914 | £0.0 |
| 1N916 | £0.06 |
| 1N4001 | £0.06 |
| 1N4002 | £0.07 |
| 1N4003 | £0.07 |
| 1N4004 | £0.07 |
| 1N4005 | £0.07 |
| 1N4006 | £0.08 |
| 1N4007 | £0.08 |
| 1N4148 | £0.05 |
| 1N4149 | £0.06 |
| 1N5400 | £0.09 |
| 1N5401 | £0.09 |
| 1N5402 | £0.10 |
| 1N5404 | £0.11 |
| 1N5406 | £0.12 |
| 1N5407 | £0.14 |
| 1N5408 | £0.15 |
| BA157 | £0.10 |
| BA158 | £0.10 |
| BA159 | £0.10 |
| BY126 | £0.13 |
| BY127 | £0.11 |
| BY133 | £0.10 |
| OA47 | £0.28 |
| OA90 | £0.07 |
| OA91 | £0.10 |
| OA200 | £0.10 |
| OA202 | £0.29 |

Zeners 2.7 to 33V

| | |
|---|---|
| 400mW | £0.08 |
| 1.3W | £0.14 |

### Bridge Rectifiers

| | | | |
|---|---|---|---|
| W005 | 1.5A | 50V | £0.19 |
| W02 | 1.5A | 200V | £0.20 |
| W04 | 1.5A | 400V | £0.22 |
| W06 | 1.5A | 600V | £0.22 |
| W08 | 1.5A | 800V | £0.27 |
| W010 | 1.5A | 1kV | £0.24 |
| BR32 | 3A | 200V | £0.36 |
| BR34 | 3A | 400V | £0.40 |
| BR36 | 3A | 600V | £0.33 |
| BR62 | 6A | 200V | £0.70 |
| BR68 | 6A | 800V | £0.59 |
| 1004 | 10A | 400V | £1.39 |
| 2502 | 25A | 200V | £1.68 |
| 2506 | 25A | 600V | £1.75 |

### Thyristors

| | |
|---|---|
| PO102AA | £0.30 |
| TIC106D | £0.36 |
| TIC116D | £0.66 |
| TIC126D | £0.77 |

### Triacs

| | |
|---|---|
| ZO105DA | £0.42 |
| TIC206D | £0.65 |
| TIC226D | £0.73 |
| BTA08-600B | £0.99 |
| TIC236D | £0.96 |

### Diac, Si. Switch

| | |
|---|---|
| DB3, 32V | £0.20 |
| BRY39 | £1.30 |

### Transistors

| | |
|---|---|
| 2N1613 | £0.31 |
| 2N1711 | £0.26 |
| 2N1893 | £0.29 |
| 2N2218A | £0.28 |
| 2N2219A | £0.25 |
| 2N2222A | £0.18 |
| 2N2646 | £0.86 |
| 2N2904A | £0.25 |
| 2N2905A | £0.25 |
| 2N2907 | £0.20 |
| 2N2907A | £0.20 |
| 2N2926 | £0.16 |
| 2N3053 | £0.27 |
| 2N3054 | £0.85 |
| 2N3055 | £0.62 |
| 2N3439 | £0.62 |
| 2N3440 | £0.50 |
| 2N3702 | £0.09 |
| 2N3703 | £0.10 |
| 2N3704 | £0.10 |
| 2N3705 | £0.10 |
| 2N3706 | £0.10 |
| 2N3771 | £1.44 |
| 2N3772 | £1.51 |
| 2N3773 | £1.70 |
| 2N3819 | £0.33 |
| 2N3820 | £0.66 |
| 2N3904 | £0.10 |
| 2N3905 | £0.10 |
| 2N3906 | £0.10 |
| 2N4036 | £0.34 |
| 2N5245 | £0.80 |
| 2N5296 | £0.57 |
| 2N5321 | £0.57 |
| 2N5322 | £0.57 |
| 2N5401 | £0.11 |
| 2N5551 | £0.11 |
| 2N6107 | £0.60 |
| 2N6491 | £1.58 |
| 2SB548 | £0.30 |
| 2SD1730 | £1.44 |
| AC126 | £0.44 |
| AC127 | £0.50 |
| AC128 | £0.40 |
| AC187 | £0.48 |
| AC188 | £0.48 |
| ACY17 | £3.84 |
| AD149 | £1.67 |
| AD161 | £0.92 |
| AD162 | £0.92 |
| BC107 | £0.16 |
| BC107B | £0.17 |
| BC108 | £0.14 |
| BC108A | £0.14 |
| BC108C | £0.16 |
| BC109 | £0.17 |
| BC109C | £0.18 |
| BC114 | £0.41 |
| BC115 | £0.41 |
| BC116 | £0.41 |
| BC118 | £0.41 |
| BC132 | £0.36 |
| BC134 | £0.36 |
| BC135 | £0.36 |
| BC140 | £0.25 |
| BC141 | £0.27 |
| BC142 | £0.31 |
| BC143 | £0.34 |
| BC149 | £0.21 |
| BC154 | £0.36 |
| BC157 | £0.12 |
| BC159 | £0.12 |
| BC160 | £0.28 |
| BC170 | £0.16 |
| BC170B | £0.16 |
| BC171 | £0.11 |
| BC171B | £0.16 |
| BC172 | £0.13 |
| BC172B | £0.13 |
| BC177 | £0.18 |
| BC178 | £0.18 |
| BC179 | £0.18 |
| BC179A | £0.17 |
| BC182 | £0.11 |
| BC182A | £0.11 |
| BC182B | £0.12 |
| BC182L | £0.08 |
| BC182LB | £0.08 |
| BC183 | £0.08 |
| BC183L | £0.08 |
| BC183LB | £0.08 |
| BC184 | £0.08 |
| BC184L | £0.08 |
| BC186 | £0.33 |
| BC204C | £0.72 |
| BC206B | £0.72 |
| BC207B | £0.74 |
| BC208 | £0.72 |
| BC209A | £0.72 |
| BC212 | £0.08 |
| BC212L | £0.08 |
| BC212LB | £0.08 |
| BC213 | £0.08 |
| BC213B | £0.08 |
| BC213LC | £0.08 |
| BC214 | £0.08 |
| BC214L | £0.08 |
| BC225 | £0.15 |
| BC237B | £0.09 |
| BC238B | £0.09 |
| BC238C | £0.09 |
| BC239C | £0.10 |
| BC250A | £0.15 |
| BC251 | £0.13 |
| BC252 | £0.13 |
| BC261B | £0.30 |
| BC262B | £0.24 |
| BC267B | £0.30 |
| BC307 | £0.10 |
| BC308 | £0.10 |
| BC319C | £0.13 |
| BC327 | £0.10 |
| BC327-16 | £0.10 |
| BC328 | £0.10 |
| BC328-16 | £0.10 |
| BC337 | £0.10 |
| BC337-25 | £0.12 |
| BC338 | £0.10 |
| BC338-25 | £0.10 |
| BC348B | £0.14 |
| BC357 | £0.25 |
| BC393 | £0.73 |
| BC414C | £0.13 |
| BC441 | £0.40 |
| BC461 | £0.40 |
| BC463 | £0.29 |
| BC478 | £0.32 |
| BC479 | £0.32 |
| BC490 | £0.24 |
| BC516 | £0.22 |
| BC517 | £0.20 |
| BC527 | £0.20 |
| BC528 | £0.20 |
| BC537 | £0.20 |
| BC546B | £0.08 |
| BC546C | £0.08 |
| BC547B | £0.09 |
| BC547C | £0.09 |
| BC548C | £0.08 |
| BC549C | £0.10 |
| BC550C | £0.10 |
| BC556A | £0.08 |
| BC557B | £0.08 |
| BC557C | £0.08 |
| BC558C | £0.08 |
| BC559C | £0.08 |
| BC560A | £0.09 |
| BC560B | £0.09 |
| BC637 | £0.21 |
| BC638 | £0.21 |
| BC639 | £0.21 |
| BC640 | £0.21 |
| BCY70 | £0.21 |
| BCY71 | £0.20 |
| BCY72 | £0.20 |
| BD124P | £6.86 |
| BD135 | £0.21 |
| BD136 | £0.21 |
| BD137 | £0.23 |
| BD138 | £0.22 |
| BD139 | £0.26 |
| BD140 | £0.25 |
| BD150C | £0.82 |
| BD165 | £0.42 |
| BD166 | £0.35 |
| BD187 | £0.39 |
| BD201 | £0.40 |
| BD202 | £0.40 |
| BD203 | £0.40 |
| BD204 | £0.40 |
| BD222 | £0.58 |
| BD225 | £0.42 |
| BD232 | £0.50 |
| BD237 | £0.32 |
| BD238 | £0.32 |
| BD240C | £0.37 |
| BD243B | £0.50 |
| BD244A | £0.53 |
| BD244C | £0.53 |
| BD245C | £1.18 |
| BD246 | £1.18 |
| BD246C | £1.18 |
| BD283 | £0.61 |
| BD284 | £0.61 |
| BD400 | £0.79 |
| BD441 | £0.41 |
| BD442 | £0.37 |
| BD534 | £0.47 |
| BD535 | £0.50 |
| BD536 | £0.65 |
| BD581 | £0.62 |
| BD597 | £0.92 |
| BD646 | £0.52 |
| BD648 | £0.52 |
| BD650 | £0.53 |
| BD707 | £0.42 |
| BD708 | £1.04 |
| BD807 | £0.80 |
| BDX32 | £1.78 |
| BDX33C | £0.49 |
| BDX34C | £0.50 |
| BDX53C | £0.47 |
| BDX54C | £0.50 |
| BF180 | £0.31 |
| BF182 | £0.31 |
| BF185 | £0.31 |
| BF194 | £0.31 |
| BF194B | £0.19 |
| BF195 | £0.19 |
| BF244 | £0.35 |
| BF244B | £0.35 |
| BF244C | £0.35 |
| BF257 | £0.33 |
| BF259 | £0.33 |
| BF337 | £0.40 |
| BF355 | £0.38 |
| BF423 | £0.13 |
| BF451 | £0.19 |
| BF459 | £0.33 |
| BF469 | £0.36 |
| BFX29 | £0.29 |
| BFX84 | £0.31 |
| BFX85 | £0.32 |
| BFY50 | £0.30 |
| BFY51 | £0.25 |
| BFY52 | £0.28 |
| BS107 | £0.21 |
| BS170 | £0.23 |
| BSW66 | £1.35 |
| BU126 | £1.32 |
| BU205 | £1.41 |
| BU208A | £1.24 |
| BU326A | £1.40 |
| BU500 | £1.54 |
| BU508A | £1.42 |
| BU508D | £1.44 |
| BU526 | £1.74 |
| BU806 | £1.06 |
| BUT11A | £1.30 |
| BUT11AF | £1.30 |
| BUX84 | £0.78 |
| IRF540 | £1.60 |
| IRF740 | £1.80 |
| MJ2501 | £1.60 |
| MJ3001 | £1.80 |
| MJ11015 | £2.11 |
| MJ11016 | £2.56 |
| MJE340 | £0.40 |
| MJE350 | £0.48 |
| MPSA05 | £0.14 |
| MPSA06 | £0.12 |
| MPSA13 | £0.12 |
| MPSA42 | £0.17 |
| MRF475 | £7.28 |
| TIP29C | £0.31 |
| TIP30C | £0.31 |
| TIP31C | £0.41 |
| TIP32C | £0.41 |
| TIP33C | £0.72 |
| TIP41A | £0.48 |
| TIP42C | £0.52 |
| TIP47 | £0.48 |
| TIP48 | £0.62 |
| TIP50 | £0.53 |
| TIP121 | £0.35 |
| TIP122 | £0.48 |
| TIP125 | £0.46 |
| TIP127 | £0.40 |
| TIP132 | £0.46 |
| TIP137 | £0.56 |
| TIP142 | £1.08 |
| TIP147 | £1.12 |
| TIP2955 | £0.97 |
| TIP3055 | £0.63 |
| VN10KM | £0.48 |
| VN66AFD | £1.50 |
| ZTX300 | £0.16 |
| ZTX500 | £0.16 |

**SAMEDAY DESPATCH**

**No Minimum Order Value**

### Electrolytic Radial Capacitors

| µF | 16v | 25v | 63v | 100v | 450v |
|---|---|---|---|---|---|
| 0.47 | --- | --- | £0.05 | £0.07 | --- |
| 1.0 | --- | --- | £0.05 | £0.06 | £0.23 |
| 2.2 | --- | --- | £0.05 | £0.06 | £0.31 |
| 4.7 | --- | --- | £0.05 | £0.08 | £0.39 |
| 10 | £0.05 | £0.05 | £0.06 | £0.08 | £0.44 |
| 22 | £0.05 | £0.05 | £0.09 | --- | £0.85 |
| 47 | £0.06 | £0.06 | £0.11 | --- | £0.98 |
| 100 | £0.06 | £0.09 | £0.11 | --- | --- |
| 220 | £0.09 | £0.12 | £0.31 | --- | --- |
| 470 | £0.15 | £0.19 | £0.57 | --- | --- |
| 1000 | £0.22 | £0.29 | --- | --- | --- |
| 2200 | £0.37 | £0.57 | --- | --- | --- |
| 4700 | --- | £1.11 | --- | --- | --- |

### Electrolytic Axial Capacitors

| µF | 16v | 25v | 63v | 100v | 450v |
|---|---|---|---|---|---|
| 0.47 | --- | --- | --- | £0.15 | --- |
| 1.0 | --- | --- | £0.11 | £0.10 | £0.19 |
| 2.2 | --- | --- | £0.10 | £0.10 | £0.22 |
| 4.7 | --- | --- | £0.10 | £0.10 | --- |
| 10 | --- | --- | £0.12 | £0.12 | £0.57 |
| 22 | --- | £0.12 | £0.13 | £0.17 | £1.06 |
| 47 | £0.10 | £0.11 | £0.16 | £0.20 | --- |
| 100 | £0.10 | £0.14 | £0.21 | --- | --- |
| 220 | £0.13 | £0.18 | £0.42 | --- | --- |
| 470 | £0.21 | £0.24 | £0.69 | --- | --- |
| 1000 | £0.33 | £0.40 | £1.05 | --- | --- |
| 2200 | £0.52 | £0.64 | --- | --- | --- |
| 4700 | £0.90 | --- | --- | --- | --- |

### Resistors

| | |
|---|---|
| ¼W Carbon Film 5% E12 Series 1Ω-10M | £0.02 Each, £0.60 per 100 |
| ½W Carbon Film 5% E12 Series 1Ω-10M | £0.02 Each, £0.95 per 100 |
| ¼W Metal Film 1% E24 Series 10Ω-1M | £0.04 Each, £1.72 per 100 |
| Enclosed Presets, Horz / Vert. 100Ω - 1M0 0.15W | £0.15 Each |
| Skeleton Presets Horz / Vert. 100Ω - 1M0 0.1W | £0.11 Each |
| POTS ¼" Shaft 25mm Dia 470Ω - 2M2 Lin or Log | £0.42 Each |

per 100 of one value only

**Please State Value(s) Required**

### DIL Sockets

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 Pin | £0.07 | 14 Pin | £0.11 | 16 Pin | £0.15 | 18 Pin | £0.15 |
| 20 Pin | £0.16 | 24 Pin | £0.19 | 28 Pin | £0.22 | 40 Pin | £0.25 |

Out Now

## New 1996 PCB Production Catalogue

A Fully illustrated catalogue covering everthing you require to Prototype & Design circuits and Manufacture Printed Circuit Boards. From simple Stripboard or Breadboard Development to Artwork Design, PCB Materials, Chemicals, Equipment and Tools.

**Many New Products and all at LOW Prices**

FREE .... with any order over £7.50 when requested.
(Please quote Order Code 000-120 to recieve a copy)
or .... send a S.A.E (A4 & stamps to the value of 47p)

ORDERING INFORMATION - All Prices Exclude Vat (17½%), Add £1.25 carriage & Vat to all orders. Send Payment with Order. PO / Cheques payable to ESR Electronic Components. Credit Card Orders Accepted. NO Credit Card Surcharges. Trade discount for Schools & Colleges.

# EVERYDAY PRACTICAL ELECTRONICS

**VOL. 25 No. 3** **MARCH '96**

**Editorial Offices:**
EVERYDAY PRACTICAL ELECTRONICS EDITORIAL
ALLEN HOUSE, EAST BOROUGH, WIMBORNE
DORSET BH21 1PF
Phone: Wimborne (01202) 881749
Fax: (01202) 841692. DX: Wimborne 45314
**Due to the cost we cannot reply to orders or queries by Fax.**
See notes on **Readers' Enquiries** below – we regret lengthy technical enquiries cannot be answered over the telephone.

**Advertisement Offices:**
EVERYDAY PRACTICAL ELECTRONICS
ADVERTISEMENTS
HOLLAND WOOD HOUSE, CHURCH LANE
GREAT HOLLAND, ESSEX CO13 0JS
Phone/Fax: (01255) 850596

## FIRST

The publication of the *Dolby Pro-Logic Decoder* in the booklet to be given away *Free* with next month's issue represents a first in the UK. In fact we are not aware of any other kit available anywhere in the world for this item.

This project was jointly developed by Silicon Chip and Jaycar in Australia and has been approved by Dolby Laboratories. The project is only available in kit form as this is the only way to satisfy the Dolby licensing requirements.

The booklet will also give a full description of how the Pro-Logic system works. Back in the 60s and 70s there were a number of "surround sound" audio systems available from various companies but, due to the lack of any standard, these all fell by the wayside. Dolby Pro-Logic has become the standard for "cinema sound" on films and videos and is now used throughout the world. This has ensured its acceptance and the range of available equipment, both built into TV sets, as HiFi separates and in mini and midi hifi systems, has rapidly grown and no doubt will continue to do so.

## PRICE BREAK

Our project enables a decoder to be built for under £100 (although that price does not include the case), thus making it a realistic add-on unit for the hobbyist with some constructional experience. It is not very often that items of this nature can be built for less than the cost of similar commercial products but in this case there is a good saving to be made. No doubt this situation will change over the next three to five years as Dolby Pro-Logic gradually becomes standard on most commercial TV and hifi systems but, thanks to this excellent project, you can enjoy the experience of "cinema sound" in your home now!

If you have any doubts about just what a difference this system makes to the enjoyment of watching a film then go and experience a demonstration at your local retailer – you will be impressed!

Mike Kenward

## SUBSCRIPTIONS

Annual Subscriptions for delivery direct to any address in the UK: £24. Overseas: £30 (£47.50 airmail). Cheques or bank drafts (**in £ sterling only**) payable to *Everyday Practical Electronics* and sent to EPE Subscriptions Dept., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Subscriptions start with the next available issue. We accept Access (MasterCard) or Visa. (For past issues see the *Back Issues* page).

## BINDERS

Binders to hold one volume (12 issues) are available from the above address. These are finished in blue p.v.c., printed with the magazine logo in gold on the spine. Price £5.95 plus £3.50 post and packing (for overseas readers the postage is £6.00 to everywhere except Australia and Papua New Guinea which cost £10.50). *Normally sent within seven days but please allow 28 days for delivery – more for overseas orders.*

***Payment in £ sterling only please. Visa and Access (MasterCard) accepted, minimum credit card order £5. Send or phone your card number and card expiry date with your name, address etc.***

**Editor:** MIKE KENWARD
**Secretary:** PAM BROWN
**Deputy Editor:** DAVID BARRINGTON
**Technical Editor:** JOHN BECKER
**Business Manager:** DAVID J. LEAVER
**Subscriptions:** MARILYN GOLDBERG
**Editorial:** Wimborne (01202) 881749
**Advertisement Manager:**
PETER J. MEW, Frinton (01255) 850596
**Advertisement Copy Controller:**
DEREK NEW, Wimborne (01202) 882299

### READERS' ENQUIRIES

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply *must* be accompanied by a **stamped self-addressed envelope or a self-addressed envelope and international reply coupons. Due to the cost we cannot reply to queries by Fax.**

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.

### COMPONENT SUPPLIES

**We do not supply electronic components or kits** for building the projects featured, these can be supplied by advertisers.

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

We regret that **we cannot provide data, or answer queries, on projects that are more than five years old.**

### ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY PRACTICAL ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or in inserts.

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them to the advertiser.

### TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before buying any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use or ownership. The laws vary from country to country; overseas readers should check local laws.

Constructional Project

# MIND MACHINE Mk III

## ANDY FLIND

Part One

*Why wait? Capture that "feel good factor" now with this latest relaxation machine.*
*A "user friendly" Programmer will be added next month.*

FOLLOWING on the popularity of the earlier *Mind Machine* designs of a couple of years ago, the time seems about right for an updated version. New technology and fresh circuit techniques have made it possible to produce a design that is simpler and cheaper to construct, and experience gained with the original units has led to a more "user friendly" control system.

Readers who saw the previous designs will probably be familiar with the principles of brainwave biofeedback and "entrainment", but for those new to the concept, here is a potted history and description of the use of these techniques.

### BRAINWAVES

Ever since the development of electronic technology made it possible, researchers have been studying the electrical activity of the human brain. This is known to employ rhythmic signals, mostly in the range of 2Hz to 20Hz, and some of these have been found to correlate with certain mental states.

At some time during the 1960s, the age of "Woodstock" and "Flower Power" and all that – hands up those old enough to remember it! – someone decided to examine the signals occurring in the brain of a Zen adept during deep meditation. A high level of "Alpha", a frequency of around 8Hz to 14Hz, was discovered.

Subsequently it was found that a person using a monitor to indicate this activity in their own brain could quickly learn to produce it at will and in greater strength, and for a brief time in those far-off heady days some of us thought we'd found the secret of life! With a simple alpha monitor, we could all become Zen Masters overnight!

Sadly, of course, it wasn't that simple. Most people either couldn't produce the signals despite the monitor, or they experienced at best a pleasant "relaxed awareness", good for stress relief, but hardly the expected "Nirvana". In addition, the monitors were relatively difficult to design due to the tiny amplitudes of the signals they had to detect, and they were tedious to use with electrodes contacting the scalp through the hair with dollops of messy electrode "gel".

Time has moved on, and with it has come new knowledge and technology (though sadly, as yet, no instant Nirvana). Most enthusiasts of this field now know that there are at least *four* generally recognised brainwave frequency bands with corresponding mental states.

The highest is *Beta*, 15Hz and upwards, found during the normal alert state. Hopefully, *EPE* readers will be generating Beta whilst absorbing this article! The *Alpha* mentioned earlier, 8Hz to 14Hz, is generally believed to promote "relaxed awareness".

Below this comes *Theta*, 4Hz to 7Hz, associated with day-dreaming and of considerable interest to many users for promoting creativity. Below 4Hz is *Delta*, found normally in deep sleep and young babies.

### OUTSIDE INFLUENCES

The passive monitors used by the early experimenters have mostly given way to "entrainment" devices using various external stimuli to encourage production of the desired brainwave frequencies, instead of just detecting and indicating what happens to be there. The two most popular stimuli are flashing l.e.d.s placed close to the eyes, and "hemisync" sound played through headphones.

Instruments of this type are now available commercially. Common in America, they are only just beginning to catch on in Britain, though readers may have spotted occasional newspaper advertisements for a machine operating on this principle. It's priced at around £250.00, and "programs" appear to be restricted to those available on tape from the suppliers, so it's still worth constructing your own.

### MIND MACHINE

So what will it do for you? Most users say that they find the experience very relaxing, with effects persisting for some time after the session has ended. It is sometimes similar to meditation, though experienced meditators say it is "different". However, in this age of stress and stress-related sickness, anything that promotes such mental relaxation has to be worth trying. With this project, readers can have a first-class entrainment machine for a fraction of the normal cost.

## WARNING NOTICE

Photic stimulation at Alpha frequencies can cause seizures in persons suffering from Epilepsy. For this reason such people MUST NOT try this project.

A user who is not a known epileptic, but when using the *Mind Machine* begins to experience an odd smell, sound or other unexplained effects, should TURN IF OFF IMMEDIATELY and seek professional medical advice.

Because of the above possibility, the *Mind Machine* should not be used while on your own.

**YOU MUST TREAT THIS UNIT WITH DUE RESPECT**

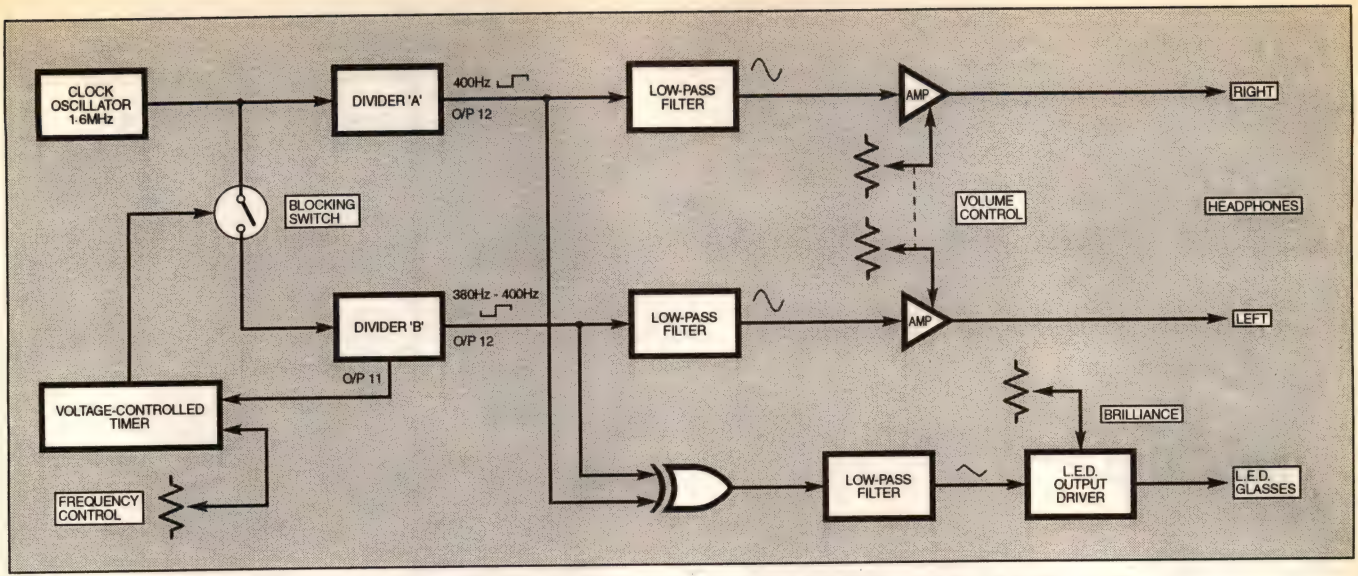


*Fig. 1. Block schematic diagram of the Mind Machine Mk III Sound and Light circuit.*

The use of flashing lights to induce specific brainwave frequencies is by far the most effective technique, but "hemisync" sound is also useful. A combination of the two stimuli is very potent, and has been used in most of the previous *Mind Machine* projects.

Some readers will be familiar with the "beat note" effect, where two tones with frequencies differing by a few Hertz combine to produce a "wah-wah" effect with their changing phase relationships. With "hemisync", the two tones are played separately, one into each ear, through headphones and the "beat" is synthesised within the brain itself.

The term "hemisync" was coined by the inventor of this technique and the sound, as perceived by the user, is a pleasantly soothing bell-like tone. Combined with lights flashing at the same frequency it is very effective indeed so the *Mind Machine Mk. III,* like its predecessors, uses both stimuli simultaneously.

"Programming" the circuit to follow a preset frequency pattern during use enhances effectiveness considerably, and projects for doing this will be presented in subsequent articles. Constructors who still have the author's original *Mind Machine* might like to know that the new programmers will be compatible with the original sound and lights board, and their use with this will be explained.

## CLOCKING-OFF

In generating the sound and light effects, the greatest problem is to produce two audio frequencies just a few Hertz apart and control their difference reliably. At first sight the task seems easy, but in practice two oscillators of similar frequency will tend to lock-on or "pull" to each other, and most simple oscillator circuits are just not sufficiently stable anyway.

The method used for all the *Mind Machines* has been to start with a single, much higher "clock" frequency and reduce this through two dividers to obtain the two audio frequencies. One is used directly. The other has a circuit that, during each half-cycle of the output, blocks a few cycles of the input clock so that it runs at a slightly lower frequency than the first.

The "clock-blocking" period is easily adjustable so the output frequency difference is simply and accurately controlled, and since both outputs arise from a single clock oscillator the "pulling" problem doesn't exist. The snag is that adjustment is actually in discreet steps, and to keep these acceptably small the clock frequency must be relatively high.

In this and previous designs a clock frequency of 1·6MHz has been used with 12-stage dividers giving output signals of about 400Hz. A block diagram of this system is shown in Fig. 1.

Low-pass filtering converts the squarewave signals from the dividers into something close to sinewaves, and power amplifiers then drive the headphones. Note that the frequencies shown are approximate, and it doesn't actually matter which audio output is "left" and which "right"!

The control signal for the l.e.d.s is obtained by combining the audio signals through an Exclusive-OR gate, which produces their sum and difference frequencies. The sum is removed by a low-pass filter, leaving the difference frequency to operate the lights. Current control is used to adjust the brilliance.

## CIRCUIT DESCRIPTION

The full circuit diagram for the Mind Machine Mk. III is shown in Fig. 2. The original Mind circuit used a crystal oscillator chip to generate the 1·6MHz clock, because CMOS *R-C* relaxation oscillators are unreliable at high frequencies. However, *L-C* oscillators are very stable and can

be built with a single CMOS inverter, such as one of the two to be found in IC4, a 4060B, which also contains the twelve stages of division needed to produce the first audio signal. Inductor L1 is a 100µH "choke", a wire-ended component just fractionally larger than a resistor, and together with capacitors C1 and C2 complete the resonant circuit.

The other internal inverter of IC4 conveniently supplies a buffered clock output from pin 9 for driving the second divider IC2, a 4040B. Control of the frequency difference is achieved by blocking this signal with IC1, an LM393 dual comparator. The outputs of this are, unlike ordinary op.amps, open transistor collectors so they can sink current to negative supply but cannot source it.

## HOW IT WORKS

The circuit works as follows. Pin 15 of IC2 is the output preceding the one from which the audio signal is taken, so it has twice the frequency. Each time it goes positive the voltage applied through resistor R5 to IC1b pin 6 turns on the output which sinks the clock signal from R8 to ground.

At the same time, capacitor C2 starts charging through resistor R4. When the voltage across C2 exceeds the control voltage from R2, the output of IC1a turns on and sinks the current from R5 to ground, causing IC1b to release the clock signal again.

Since IC2 is a negative-edge triggered device and this action takes place on positive edges of the signal from pin 15, the clock-blocking takes place conveniently midway through each half-cycle of the final output. The higher the control voltage from R2, the longer the blocking period so the greater the difference in output frequencies. Although the action is related to the exponential charging of C1, if a maximum of half the supply voltage is used for control the frequency difference will appear to be linear with control voltage.

Passive filtering is applied to the squarewave divider outputs by resistors R9 and R10 with capacitors C5 and C6 on one side and R14 and R15 with C18 and C19 on the other. This converts them to approximately sinusoidal form, after which they pass through the "Volume" control VR1a and VR1b to IC3, a TDA2822 stereo amplifier.

This provides more than adequate drive from socket SK1 for a pair of "Walkman" type headphones, or the FREE cover-mounted headphones. Constructors of the original Mind Machine may remember that active filters were used to shape the signals, but this passive circuit works just as well. The previous design used two output chips in a quest for lower noise, but the single device used here is sufficient. More will be said about this later.

## LIGHTING-UP TIME

The two divider outputs are also connected to IC5b, an Exclusive-OR gate. One of them, from IC4, first passes through IC5a. This inverts the signal polarity if the Phase switch S1 is closed, so the lights can be in either normal or opposite phase to the sound. Users can try both and make their own decisions as to which appears most effective.

The output of IC5b is a series of pulses with a duty cycle dependant upon the relative phase of the two inputs. The resulting average level is a triangular wave synchronised with the difference between the input frequencies.

Simple filtering by resistor R20 and capacitor C22 extracts this average, to which a d.c. voltage is added by R18 and R19 so that the output of IC5c is positive for about a quarter to a third of each cycle. IC5d reverses IC5c's output polarity.

Once again, in the original design active filtering was used with a comparator for determining the switching points. This circuit manages the whole operation with a single CMOS chip. Viewed on an oscilloscope, there is a bit of "splatter" around the switching points, but since the eye cannot see an 800Hz flicker this is not a problem.

Unlike its predecessor, this circuit uses only one l.e.d. driver. Improvements in l.e.d. performance provides sufficient stimulation with just one l.e.d. for each eye, and the two in series can be driven by the single output stage. The driver, IC6 with transistors TR1 and TR2, is actually a voltage-controlled current sink.

The control voltage from VR2 determines the current that will be drawn through the l.e.d.s connected to socket SK2. Note that VR2 is a "log" type since the eye, like the ear, has a logarithmic amplitude response!

The action of the signal from pin 11 of IC5d is to turn off the l.e.d.s by injecting positive current into the feedback loop of the driver circuit through resistor R22 and diode D1. This ensures that the lamps turn fully off by forcing the output of IC6 all the way to negative supply. The "end

## COMPONENTS

**See SHOP TALK Page**

### Resistors

| | |
|---|---|
| R1 | 5k6 |
| R2 | 470k |
| R3 | 560Ω |
| R4, R10, R15, R17, R19 | 100k (5 off) |
| R5, R6, R7 | 22k (3 off) |
| R8, R22, R23, R24, R25 | 10k (5 off) |
| R9, R14 | 15k (2 off) |
| R11, R16 | 150k (2 off) |
| R12, R13 | 4Ω7 (2 off) |
| R18 | 220k |
| R20 | 1M |
| R21 | 68k |
| R26 | 15Ω |

Plus 4k7 for testing
All 0·6W 1% metal film

### Potentiometers

| | |
|---|---|
| VR1 | 10k dual rotary carbon, log |
| VR2 | 10k rotary carbon, log |
| VR3 | 10k rotary carbon for testing, lin |

### Capacitors

| | |
|---|---|
| C1, C8, C9, C21 | 10µ radial elect. 50V (4 off) |
| C2 | 1n polystyrene |
| C3, C4, C17, C23, C26, C27, C28 | 100n resin-dipped ceramic (7 off) |
| C5, C7, C13, C14, C18, C20 | 100n polyester layer (6 off) |
| C6, C19 | 10n polyester layer (2 off) |
| C10, C11, C12 | 100µ radial elect. 25V (3 off) |
| C15 | 220p polystyrene |
| C16 | 150p polystyrene |
| C22 | 1n polyester layer |
| C24 | 1n resin-dipped ceramic |
| C25 | 4700µ radial elect. 16V |

### Semiconductors

| | |
|---|---|
| D1, D2 | 1N4148 diode (2 off) |
| TR1 | BC184L *npn* transistor |
| TR2 | BC214L *pnp* transistor |
| IC1 | LM393 Dual comparator |
| IC2 | 4040B CMOS 12-stage binary counter |
| IC3 | TDA2822 Stereo power amplifier |
| IC4 | 4060B CMOS 14-stage binary counter with oscillator |
| IC5 | 4070B CMOS Quad Exclusive-OR gate |
| IC6 | CA3130 CMOS op.amp |

### Miscellaneous

| | |
|---|---|
| SK1 | Stereo jack socket |
| SK2 | Mono jack socket |
| L1 | 100µH wire-ended r.f. choke |
| S1, S2 | Sub-min. slide switch (2 off) |
| B1 | 6 or 8 AA cells in holder, see text |

Printed circuit board available from the *EPE PCB Service,* code 980; plastic case, size to choice; 8-pin d.i.l. socket (3 off); 14-pin d.i.l. socket; 16-pin d.i.l. socket (2 off); control knobs (2 off); 5mm 3·5cd Hyperbright l.e.d., 2 or 4 off (see text); multistrand connecting wire; screened lead; solder pins; solder etc.

*Approx cost guidance only* **£25**
*excluding case & batts.*

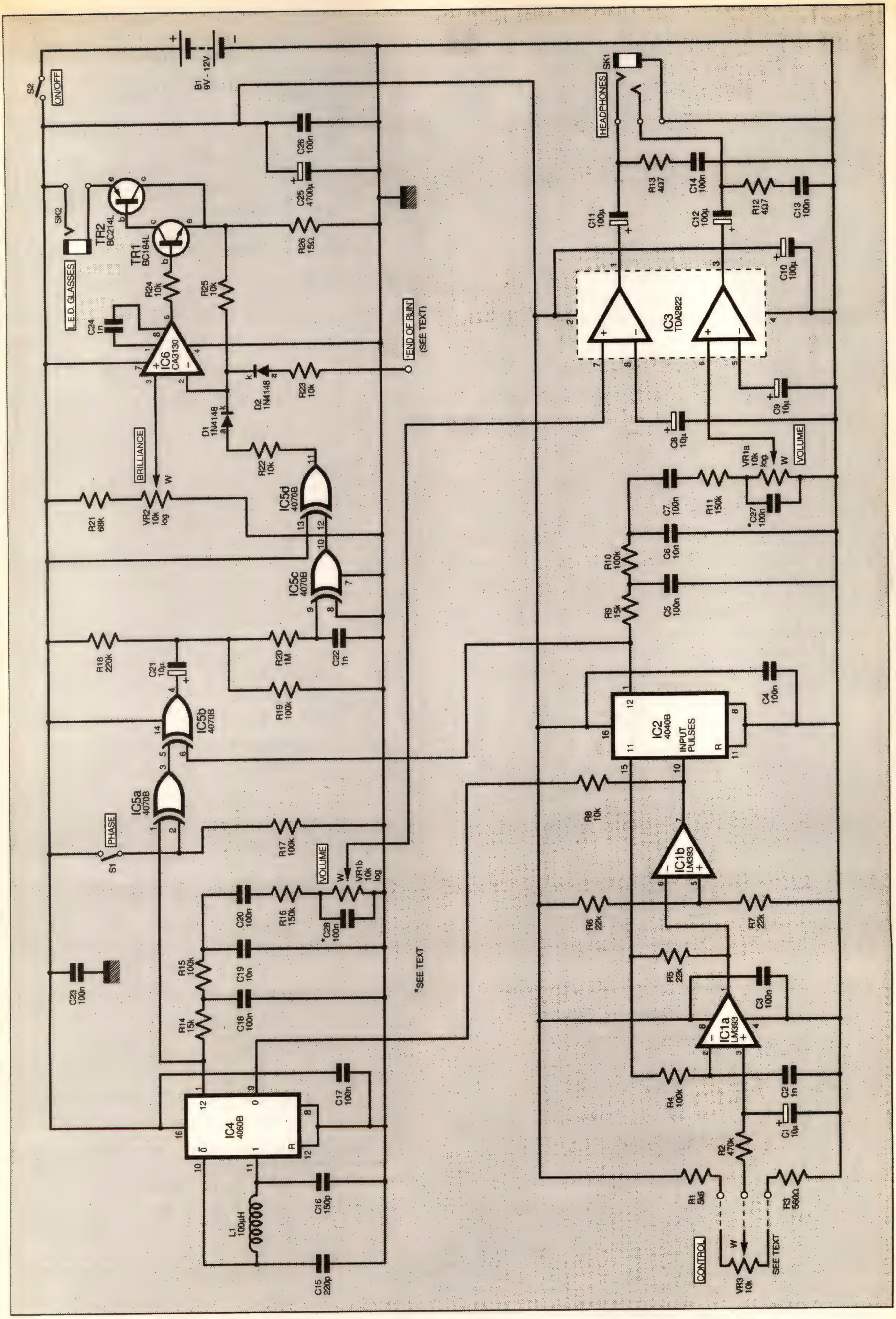


*Fig. 2. Complete circuit diagram for the Sound and Light stages of the Mind Machine Mk III.*

of run" input is provided for use with program generating circuits which can use a positive output signal to turn off the l.e.d.s.

This circuit has no supply voltage regulation. All the control voltages, including that from the programmers to be described in future issues, are relative to the supply so voltage regulation is unnecessary. It operates happily with supplies anywhere between 7V and 15V, the lower limit being set by the l.e.d. driver requirements and the upper one by the CMOS devices used.

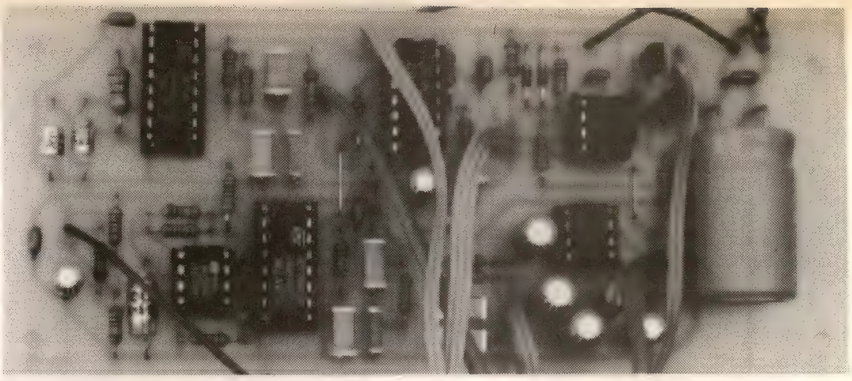
The normal supply is 9V, though masochists might like to try four l.e.d.s in series with a 12V supply. The prototype uses a pack of eight "AA" NiCads supplying just under 10V.

## CONSTRUCTION

Construction and testing of this project is quite straightforward. The Sound and Light printed circuit board (p.c.b.) is available from the *EPE PCB Service*, code 980.

The positions for all the board components and full size copper foil master are shown in Fig. 3. For ease of construction the following assembly and testing procedure is recommended.

Firstly, all the passive components and diodes should be fitted, in order of physical height. This covers the two wire links, diodes D1 and D2, all the resistors, the tiny ceramic capacitors and the choke L1. Almost any 100μH inductor will work in this circuit, but the wire-ended type specified is simple to use and has a reasonable tolerance value of 10 per cent.



*Completed Mind Machine p.c.b. The radial smoothing capacitor C25 is laid flat on the board.*

Six d.i.l. sockets should be fitted for the i.c.s. The use of these is recommended as they greatly simplify testing and troubleshooting. Should the project ever become redundant, the expensive i.c.s can be recovered easily, too.

The two transistors and the larger capacitors can now be fitted, ending with the electrolytics, but the 4700μF capacitor C25, should be omitted at this stage. This capacitor, intended to help the battery supply the bursts of current required by the l.e.d.s, can store enough energy to damage some of the other components so it should be fitted when testing is complete and the circuit is known to be working correctly.

Leads should be attached for the various control and signal connections, see Fig. 4. Screened leads should be used for connections to VR1, as these carry low level signals.

## TESTING

Testing of the board can be commenced using a 9V supply, preferably from a current-limited bench PSU, though a 9V pack of AA cells could be used if necessary. During tests the current drawn by the circuit should be monitored.

Following a careful check of the construction and soldering, the board should be powered without any of the i.c.s fitted and, following an initial "kick" as the electrolytics charge, the current drawn from the supply should be negligible. With the prototype it was less than 20μA.

If this is satisfactory the oscillator and first divider IC4 should be inserted in its holder and power re-applied. Note that IC4, like some other i.c.s in this circuit, is a CMOS type so the usual anti-static handling

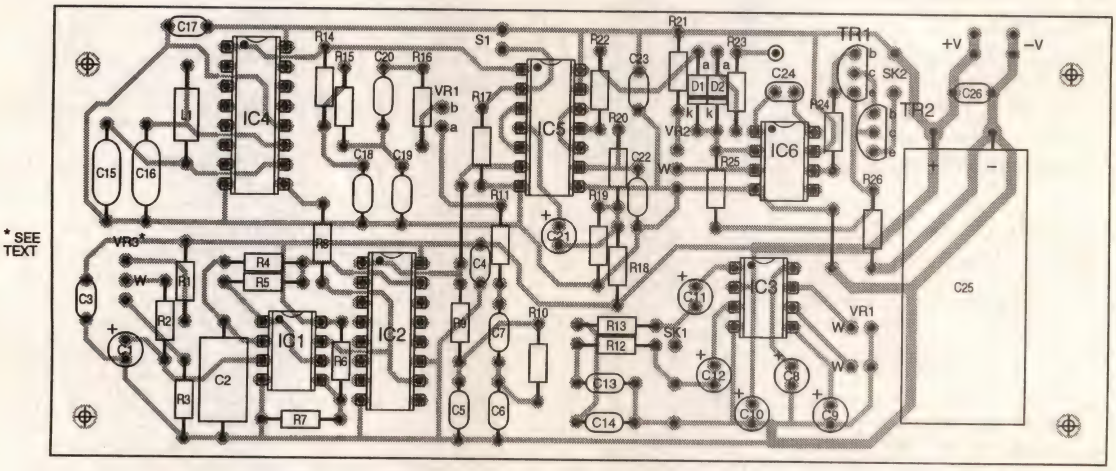
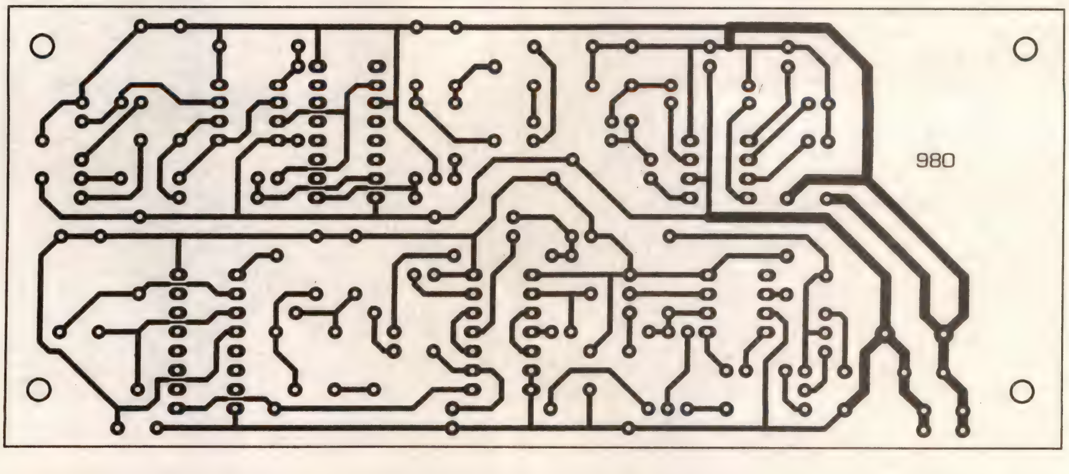


*Fig. 3. Printed circuit board top side component layout and full size copper foil master pattern.*



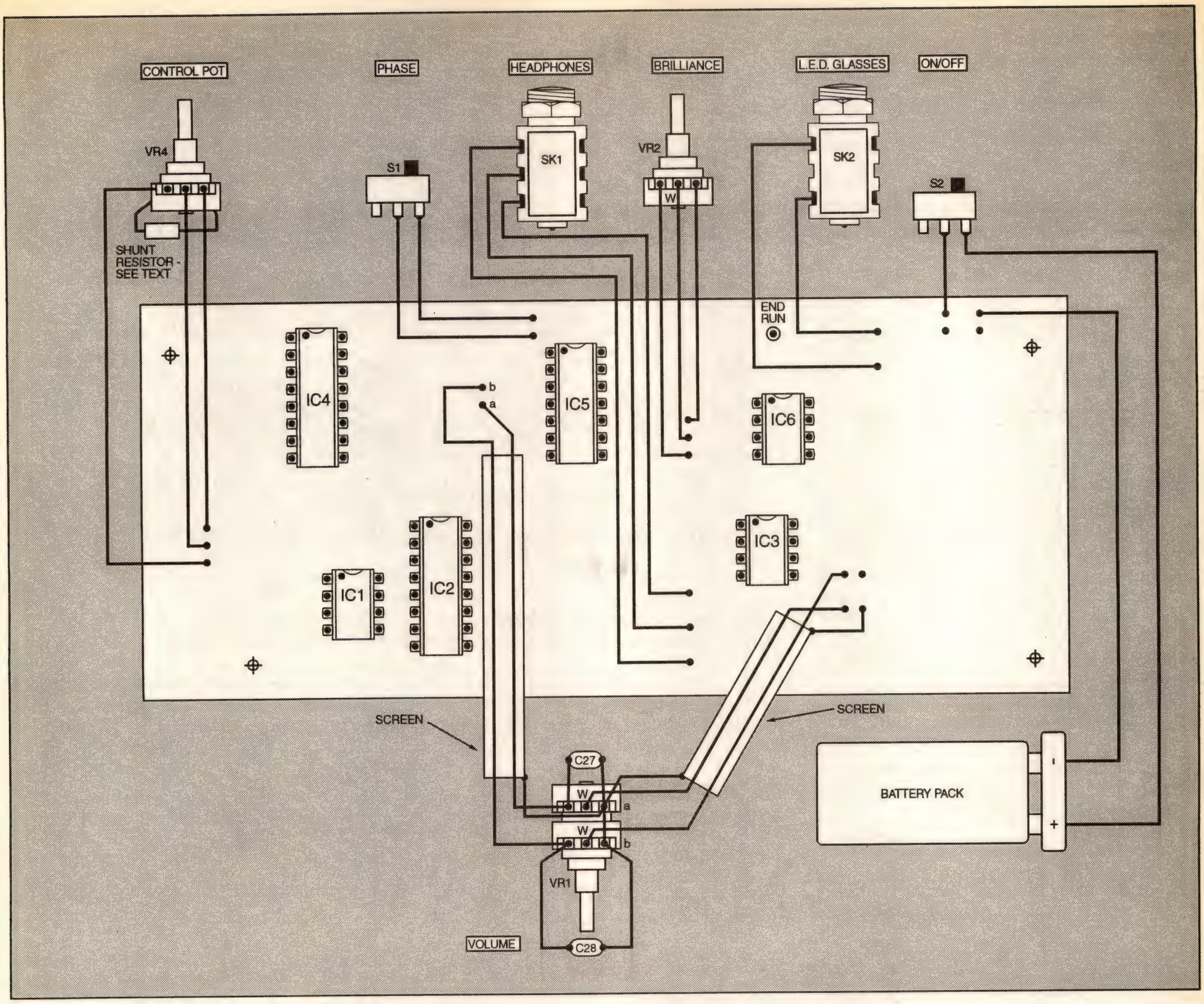


*Fig. 4. Interwiring from the p.c.b. to off-board components. The phones and glasses sockets should be the plastic insulated types.*

measures should be taken. If the oscillator is running correctly the supply current should be around 2mA and pin 1 of the i.c., the 400Hz output, should show an average d.c. level of half the supply on a voltmeter.

This can be followed by insertion of IC2, the second divider, which raises the current to about 3·5mA and should also have an average level of half the supply at pin 1. Next, control potentiometer VR3 should be connected to the p.c.b. input pins as shown in the interwiring diagram Fig. 4. The connection need only be temporary, and the control should be a linear type.

To allow for the large tolerance variation found in "pots", and the various types that may be used with the input, the circuit has been designed with values of resistors R1 and R3 for use with an overall control resistance of five kilohms. This can be obtained by shunting a standard 10k pot with resistor(s) selected to give this value. For testing, it is sufficient to just solder a 4k7 resistor across it as shown in Fig. 4.

The comparator IC1 and the 4070B Exclusive-OR device IC5 should now be inserted, taking the overall supply current to about 5mA to 6mA. If the circuit is working correctly pin 11 of IC5 should show a d.c. value of about 6V and at low settings of the "test" control it may be seen pulsing at about 2Hz. Allowance should be made when altering the control setting for the slow response to changes due to the time constant of R2 and C1.

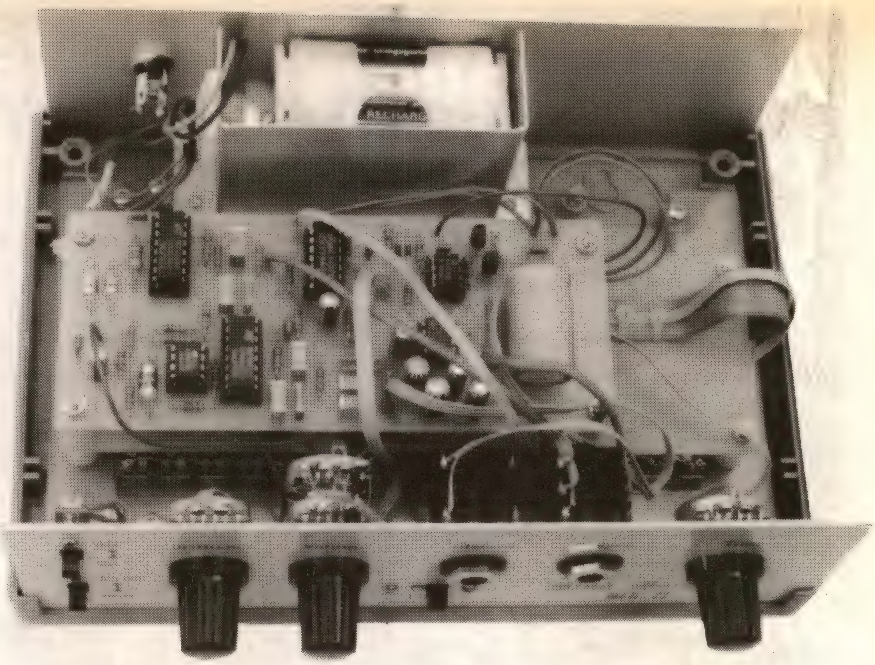
## VISUAL TEST

An l.e.d. can be connected to the output (only one is needed for testing) and the Brilliance control VR2 should also be connected to the board. With IC6 in place, the l.e.d. should now flicker or flash, with brilliance controlled by VR2 and frequency set with the control pot VR3 on the input.

Following this it remains only to connect the Volume control VR1 to the screened leads, insert IC3 and try out the sound with a pair of headphones. Each phone on its own should produce a steady tone, whilst the two together should generate the "beat note" difference between them. The overall current drawn by the circuit will depend on the Brilliance and Volume settings, but with both turned right down it should be about 15mA.

Once everything is working satisfactorily, the large electrolytic capacitor C25

can be fitted. A bit of double-sided sticky tape or a dollop of adhesive should be used to secure this to the p.c.b.


*Layout of components inside the Mind Machine Mk III case. The lower board carries the programmer section to be described next month.*

## FINAL ASSEMBLY

All the external interconnections are shown in Fig. 4. More will be said about layout in the next article, describing the programmer, but the prototype was assembled in a standard plastic case with all the controls and sockets for this board on the front panel. Where a metal panel is used, the headphone and glasses sockets should be *insulated* from it, otherwise they may short-circuit the supply.

Two points should be noted regarding sound quality. Because the two tones from this circuit are very pure, any noise or distortion can be unusually obvious and annoying, and two sources may be encountered.

The first is breakthrough of higher frequencies from other parts of the circuit, perceived as a slight "whine" on the output. This is easily cured by placing two 100nF ceramic capacitors, C27 and C28, across the two sections of the volume control VR1 as shown in Fig. 4.

A second is amplifier "hiss". In the original design this was eliminated by careful selection of device (hence the two separate i.c.s), and capacitance across the output, but this was a compromise as the amount required increased the supply current. A simpler solution is used with this version – cheap headphones!

Hiss will be very noticeable with expensive hifi phones, but a pair of really cheap ones just won't have the high frequency response and so will sound fine. "In-ear" types, with foam covering, are recommended. The absence of a headband prevents them from tangling with the glasses and the foam increases comfort whilst further reducing the hiss. Well, who wants to put high-level pure tones through their best hifi headphones anyway?

## MAKING A SPECTACLE

The "glasses" should be constructed using plastic-lensed glasses of some kind as a base. Cheap ski goggles look good, but swimming goggles were preferred as these place the l.e.d.s very close to the eyes and their positions are to some extent individually adjustable.

The l.e.d.s are the highest output 5mm "Hyperbright" types obtainable, with output quoted as 3·5mcd, though 1mcd types should prove very nearly as effective. They are connected in series, and pressed into holes drilled in the lenses and connected as shown in Fig. 5.

Care is needed to find the optimum positions for them, remembering that when the user's eyes are *closed* and relaxed the eyeball position may alter slightly. A good way of locating the best position is to attach the l.e.d.s temporarily to some thin flexible wire, connect them to the circuit, put on the glasses, sit with *eyes closed* and experiment with position, using "Blu-Tak" to hold them in the best positions whilst marking out for drilling the holes.

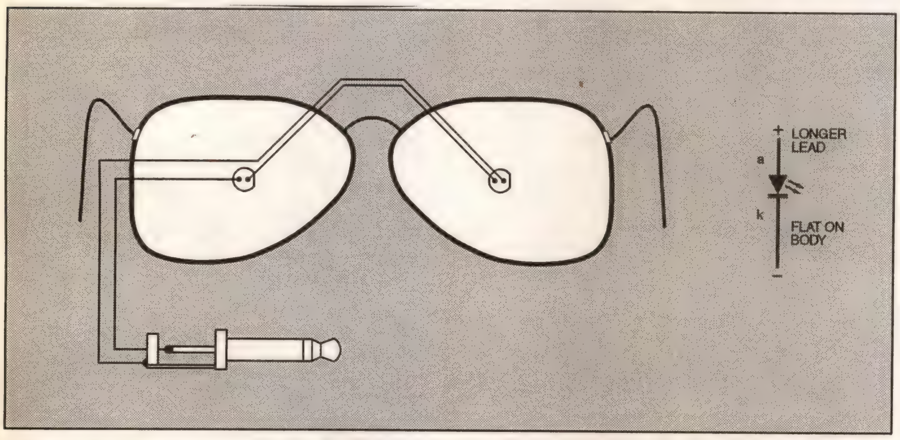
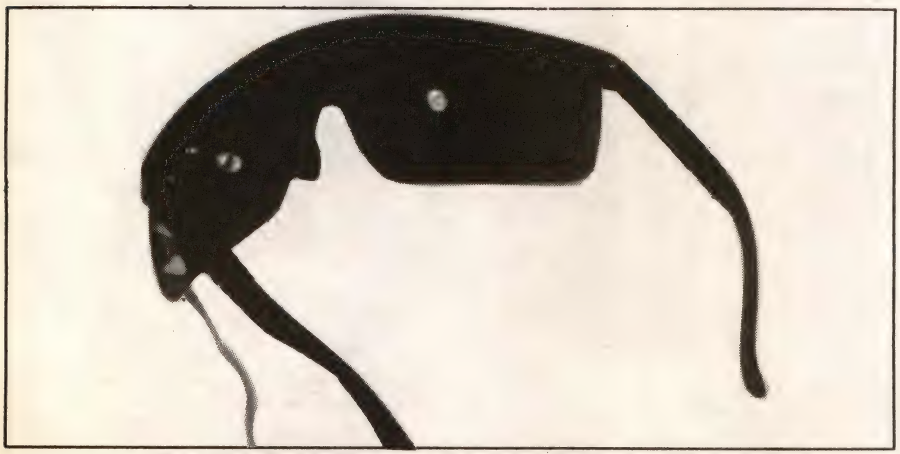


*Fig. 5. The l.e.d.s mounted in position in the glasses lens and wired to the jack plug.*


*The completed glasses with the l.e.d.s fixed in position.*

## IN USE

The circuit may be used with the manual control VR3. Users will probably find the main effect is one of beautiful relaxation. Swirling patterns and colours are sometimes experienced in the lights, especially during initial sessions.

For best results a programmed "session" of twenty to thirty minutes is recommended so next month will see the first of two program controller circuits, the first being far more user-friendly and simple to operate than any of those previously published.

**Next Month:** A 16-slider Programmer to "capture" your most relaxing mood.

NEW! NEW! NEW! NEW! NEW! NEW! NEW! NEW! NEW!

# At last! The complete PC-Based PLD Training System

ONLY £695.00

## 14 UNIQUE ADVANTAGES!

- ☑ Superb Manual
- ☑ Everything in one box
- ☑ Save time & money
- ☑ Demo area provided
- ☑ 23 worked experiments
- ☑ Menu driven for fast learning
- ☑ Includes PALASM
- ☑ 3 simultaneous PLD's
- ☑ Jumper wire linkage
- ☑ Supports GAL16V8 & GAL20V8
- ☑ 3 input, 4 output areas
- ☑ No tied up ports
- ☑ 4 FREE GAL's
- ☑ 12 month guarantee

# THE PAL TRAINER

Until now, introducing students and engineers to the world of Programmable Logic Devices has been fraught with problems.

Not only has the necessary hardware to be laboriously assembled in bits and pieces, but suitable software and - equally important - supporting documentation has been, if anything, harder to source.

With the launch of THE PAL TRAINER system from Flight Electronics International, the entire problem has been neatly solved in one comprehensive hardware/software/documentation package...

...providing everything that the engineer and student needs for a thorough introduction to PLD's at a very realistic price.

## COMPLETE & COMPREHENSIVE

One of the main advantages of THE PAL TRAINER is its completeness. The board and accessory kit consists of:

- The MPLDT-10 main unit - a sturdy metal-cased PCB containing both a GAL programmer and a test unit. There is also a separate demo area for use with the demonstration section of the manual.
- A PCPET interface card, which plugs into a free PC expansion slot, and connects to the main unit via a supplied API-37 cable. This allows rapid programming of the PLD, and greater flexibility than a serial link can deliver.
- A 360kb system diskette containing the board driver files.
- An external power line for use with the experiment section.
- Various connection lines and block jumpers.
- The comprehensive PAL TRAINER User's Manual. This has been written in precise, easy-to-understand English, and takes the student right from unpacking and setting up the system, through a short demonstration program which runs without the need to go into PALASM and then, in a gentle step-by-step sequence, through 23 separate experiments.
- The complete PALASM software package, whose separate manual also contains a number of example programs.

## SIMPLE, FAST, FRIENDLY

The design parameters of THE PAL TRAINER were that it should:

- run on IBM XT, AT or compatibles - with no need for ANY other hardware.
- provide a complete training course, from initial logic design, to PC simulation, device programming & testing.
- be enjoyable, readily-understandable, but fully applicable to 'real-world' situations.
- include a top programming language - in this case AMD's PALASM Version 4, widely regarded as the PLD standard. Version 4, incidentally, can be linked to other schematic packages such as OrCad.

**LIKE TO SEE THE PAL TRAINER IN ACTION?**
Nothing beats an actual hands-on experience of the system's completeness, ease of use, and flexibility. Just call 01703 227721 and order today! - We operate a 'no strings' 30 days 'no risk' refund.

## USING THE SYSTEM

The two main parts of the PAL TRAINER are the programmer and the applications sections.
Using the programmer section, up to 3 GAL devices are placed in ZIF sockets, and programmed from the PC using the supplied software. This lets you choose a particular PAL to emulate, loads a JEDEC file into memory (either generated from the PAL TRAINER's own software or any other appropriate software package), downloads the JEDEC file to the GAL, and even lets you 'view' the GAL once it has been programmed.

We accept: Access MasterCard VISA

Flight House
Ascupart Street
Southampton
SO14 1LU U.K.

Telephone:
01703 227721
Facsimile:
01703 330039
Email: Sales
@flight demon.co.uk

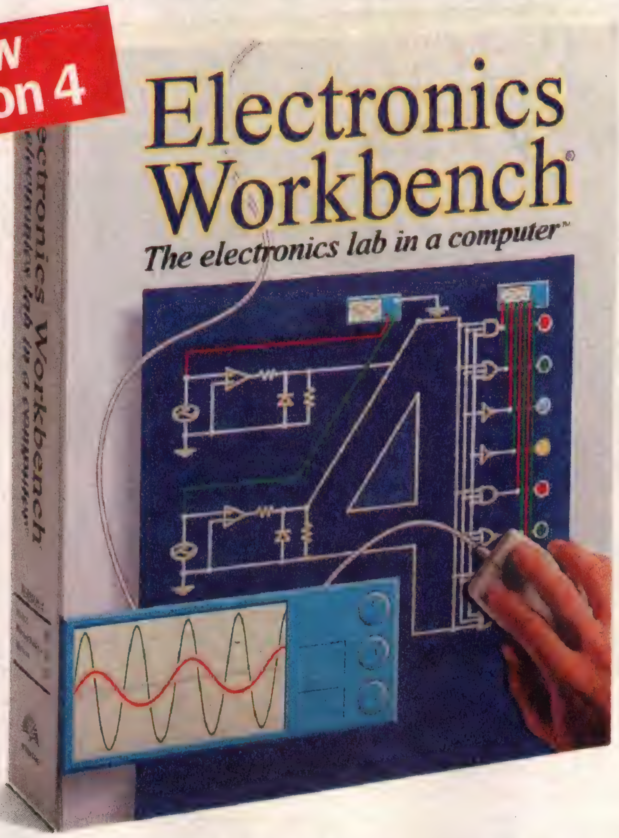
**Flight**
ELECTRONICS
INTERNATIONAL LIMITED

*Flight also make*
- ● ELECTRONIC& MICROPROCESSOR TRAINING EQUIPMENT
- ● TEST & MEASUREMENT EQUIPMENT ● PC CARDS
- ● 4 FREE COLOUR BROCHURES AVAILABLE - CALL TODAY!

TEL: 01703 227721
FAX: 01703 330039

# MIXED-MODE SIMULATION. THE POWER OF VERSION 4.

**New Version 4**


Electronics Workbench®
The electronics lab in a computer™
Electronics Workbench
The electronics lab in a computer

### Analog, Digital & Mixed Circuits

Electronics Workbench® Version 4 is a fully integrated schematic capture, simulator and graphical waveform generator. It is simple to mix analog and digital parts in any combination.

### Design and Verify Circuits… Fast!

Electronics Workbench's simple, direct interface helps you build circuits in a fraction of the time. Try 'what if' scenarios and fine tune your designs painlessly.

### More Power

Simulate bigger and more complex circuits. Faster. On average, Electronics Workbench Version 4 is more than 5 times faster than Version 3.

### More Parts

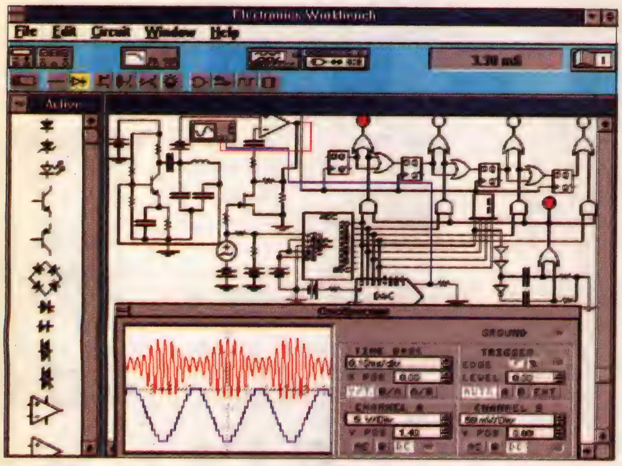
Multiple parts bins contain over twice the components of Version 3.

### More Models

Over 350 real world analog and digital models are included free with Electronics Workbench. And, if you need more, an additional 2,000 models are available.

## Incredibly Powerful. Incredibly Affordable.

If you need mixed-mode power at a price you can afford, take a look at this simulator and graphical waveform generator that mixes analog and digital with ease.



True mixed-mode simulation: Simultaneous AM transmission, digitization and pulse-code modulation of a signal.

With over 20,000 users world-wide, Electronics Workbench has already been tried, tested and accepted as an invaluable tool to design and verify analog and digital circuits. With Version 4 true mixed-mode simulation is now a reality with incredible simplicity.

# Electronics Workbench™

*The electronics lab in a computer™*

## Order Now! Just £199*

# 44-(0)1203-233-216

**Robinson Marshall (Europe) Plc**

**Nadella Building, Progress Close,**
**Leofric Business Park,**
**Coventry, Warwickshire CV3 2TF**
**Fax: 44 (0)1203 233-210**
**E-mail: rme@cityscape.co.uk**

Shipping charges UK £5.99. All prices are plus VAT.
All trade marks are the property of their respective owners.
Electronics Workbench is a trademark of Interactive Image Technologies Ltd., Toronto, Canada.
* 30 Day money-back guarantee.

Australia: 2-519-3933 • Brazil: 11-453-5588 • Cyprus: 09-641801 • Denmark: 33-25-0109 • Finland: 0-297-5033 • France: 14-908 9000 • Germany: 711-62-7740 • Greece: 1-524-9981 Hungary: 1-215-0082 • India: 11-544-1343 • Israel: 3-647-5613 • Italy: 11-437-5549 • Japan: 3-3382-3136 • Malaysia: 603-2937481 • Mexico: 5-396-3075 • Netherlands: 18-031-7666 New Zealand: 9-267-1756 • Norway: 22-16-70-45 • Portugal: 1-814-6609 • Singapore: 462-0006 • Slovenia: 61-317-830 • South Africa: 331-6-8309 • South Korea: 2-2-222-3431 Spain: 1-553 3234 • Sri Lanka: 1-86-5970 • Sweden: 8-740-5500 • Thailand: 66-2-398-6952 • United Kingdom: 203-23-3216

INTERACTIVE

# FOX REPORT

### by Barry Fox

## Encyclopaedic CDs

The new high density CDs and CD-ROMs, which are due on the market at the end of 1996, will store the equivalent of at least half a dozen conventional CDs. This means that one disc can store a shelf full of multimedia encyclopaedias, all the maps for Europe or the USA, and all the telephone numbers for a whole Continent.

The practical value of this will be immediatley obvious to anyone who juggles ROMs, just as we had to swap floppy discs to change PC programs in the days before a cheap hard disc stored everything for rapid access.

But think of the flip side.

When the first ROM encyclopaedias went on sale five years ago, they cost around £200 each. No-one bought them. There are now around 10,000 ROM titles available and the price has fallen to under £50. Encyclopaedic information has never been so cheap.

A high density CD will cost little more to press than an ordinary CD, which means they can be churned out for less than a dollar a time. But if one high density ROM holds the copyright material from six or seven ordinary ROMs, royalties will push the cost of a single disc up to several hundred pounds again.

So once again no-one will buy. Consumers will perceive the single disc as grossly over-priced. They will worry about their ROMs being stolen, or damaged. The price will once again shake down to whatever the consumer sees as the acceptable maximum, probably around £50.

The coming of high density ROM may thus have the happy side effect of driving down the cost of information to the lowest levels ever.

## Data Retrieval

The idea of low cost, bulk information dates back to 1945. Vannevar Bush was Director of the Office of Scientific Research and Developement in the USA. He co-ordinated scientific and military research. As the war ended he wrote an essay in the magazine *Atlantic Monthly*, which warned that so much information was even then being published, that the availability of information extended far beyond the world's ability to make real use of it. Someone can live in a library, surrounded by books, but still be completely ignorant.

Bush saw photographic microfilm as the likely solution. "The *Encyclopaedia Britannica* could be reduced to the volume of a matchbox", he predicted. "The library of a million volumes could be compressed into one end of a desk".

Fifty years on microfilm remains a cheap method of archiving. Libraries routinely use it to store large volumes of old paper, such as patent specifications. But you have to know the date or number of the document you are looking for, and then read through it. There is no way of automatically searching the analogue text for keywords or phrases, as is now routinely done with text stored as digital code on magnetic or optical disc.

Banks and insurance companies make microfilm copies of all old cheques and transaction documents before they destroy the paperwork. They use a highly automated system of running all the paper at very high speed through a scanner and capturing the image on silver halide film emulsion.

To cut costs the companies do not even bother to process the microfilm rolls unless or until a query comes up and which no one can answer from the existing paperwork. They then cross fingers and develop the roll that is logged as containing a latent image of the document in question. No-one has ever been able to tell me what happens if the film is fogged or faulty, or the image blurred through malfunction of the scanner.

## Internet Ferreting

I wonder what Vannevar Bush would have made of the Internet, and World Wide Web. They certainly bear out his warning of a world with too much information available. The Web straggles over so many Internet sites, with such hit and miss indexing, that searching for anything can become a full time job.

Californian software company Quarterdeck was founded in 1982, and became very successful with its Desqview multitasking and QEMM memory management systems for DOS, long before Microsoft released a stable version of Windows and the very poor Memmaker memory manager. Quarterdeck went public in 1991, ran into trouble the next year, and restructured in 1994. Staff had dropped to 200, but now it is up to 600. The company is flourishing again.

Quarterdeck still sells QEMM and it is still streets ahead of Microsoft's pale imitiations. But Quarterdeck has now started selling Internet software. One program, called Web Compass, would have suited Vannevar Bush. It is a search engine that uses keywords to ferret out information from the Internet.

It does this by first checking through a dozen or more of the existing index sites, like Yahoo, Lycos and CNN Online. The Compass search engine then uses artificial intelligence to analyse the results that come back from the index sites, and presents the searcher with a list of documents that are most likely to contain genuinely useful information.

## Semantic Search

The intelligence comes from a "semantic database" which Compass uses as a personal reference book. If, for instance, the original search instruction was to find information on "trees", the first step is send the key word "tree" to the various index sites. These will then throw up large numbers of documents which refer to shoe trees, genealogy trees, logic trees, pine trees, tree houses and whatever goes on at any place with "tree" in the address.

Compass now gets clever. It scans the text, analyses the content, creates a summary, makes a judgement on the context of the keyword and sorts the documents into groups. The system is similar to that used by some busy company executives who only ever read a computer-condensed version of their incoming Email messages!.

The grouped summaries produced by Compass are stored on the PC's hard disc for off-line reading. The heart of the software is the semantic database, which contains around 40,000 known word linkages, such as shoe and tree, genealogy and tree, pine and tree and so on.

When the database is stumped, for example if it comes up against a document on "tree surgeons" and puts them under a medical heading, the searcher can correct the classification. The search engine learns from this for next time. So the more the search engine is used the more effective it becomes as a discovery tool.

## Index-linked

Because the index sites are financed by advertising, Compass dutifully downloads some advertisements as well as searched text. Apart from this, the inevitable weak link is that the index sites only cover around half the material which is available in the Web. Everything on the Internet is changing so fast, with sites appearing and dissappearing daily, that probably no index will ever be able to catalogue everything that is available.

Intelligent search engines can only search through material that the indexes throw up. It is the price the world must pay for an Internet which is free from the kind of official control which would organise an efficient index but censor and ban some of the information, perhaps by the simple expedient of omitting it from the index.

# ARMED WITH AN EXTRA DEGREE OF SAFETY

## Advanced robotics development in the UK provides new degrees of freedom and safety for remote operators – *by Hazel Cavendish*

IN SOME respects, the world has become a more dangerous place as the frontiers of science are pushed forward. Human beings must always be protected from hazardous environments in which they are called upon to work – in space, in nuclear laboratories and deep underwater, and so on. To meet the challenge of such environments, teleoperated robotic systems are being developed.

It has long been recognised that if an operator is an essential – indeed vital – part of a teleoperated robotic system, that system must be viewed from his perspective, and designed so that he can perform his task easily and efficiently.

"There are still too many command, control and safety issues to be resolved in these hazardous unstructured environments before we leave them in the 'hands' of autonomous robots," wrote David Hooper and Cliff Boddy in an interesting recent paper. They were describing a task-centred robotic manipulator system originally developed for remote handling in nuclear environments, and now being used by the North Sea oil industry.

### ADVANCED ROBOTICS

Some most exciting work has been taking place in Manchester where a 21-strong research team has been working at the National Centre of Advanced Robotics, where they achieved three "firsts" in the field of advanced robotics. These included the "Seven Degrees of Freedom" (7DOF) teleoperation controller – which embodies collision avoidance, the automatic tip stabilisation manipulator, and a high accuracy navigation vehicle for the construction industry.

This team formed its own company called UK Robotics Ltd. at the end of 1995, substantially backed by British Nuclear Fuels and InSys. BNFL intend that their investment will help the company to employ the latest robotic technology in new business.

Their business manager, Dr Martin Bucknell, said "Working closely with UK Robotics should provide us with another string to our technology bow, as we expect their know-how will give us the edge in maintenance, safety and the decommissioning of facilities."

### TELEOPERATION TESTBED

A collaborative group of British companies, interested in solving a variety of remote handling problems in the nuclear industry, came together in 1993 to define the Advanced Teleoperation Testbed (ATT), founded upon the successful work undertaken at the National Advanced Robotics Centre. InSys, as the prime contractor, undertook all the R&D work.

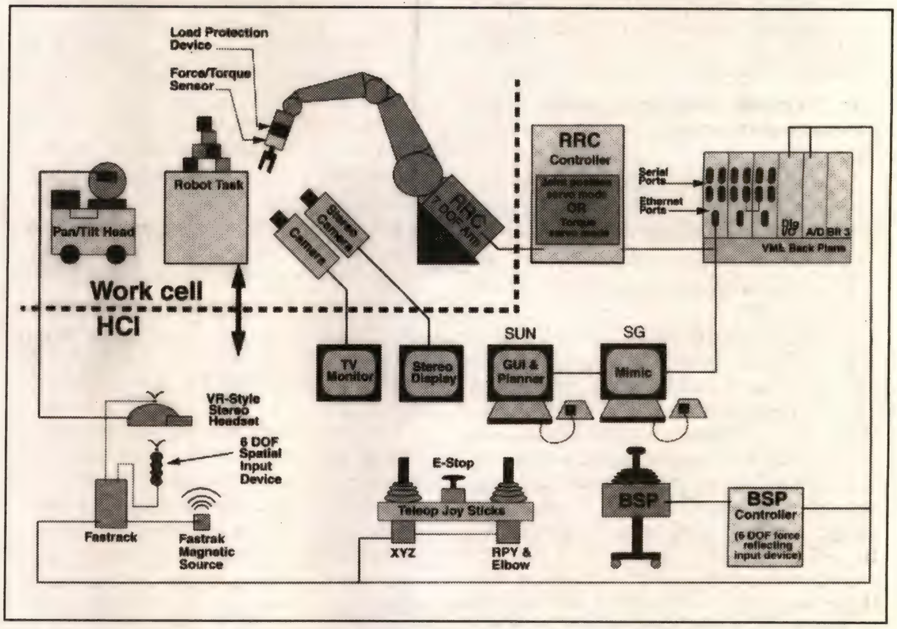


*Fig. 1. Overview schematic of the ATT system.*

The ATT system is the result of the integration of two robotic systems, and a wide variety of other input and output hardware and software spread across four computer programs. A simplified schematic of the physical system is shown in Fig. 1, which is re-interpreted from a task-centred point of view in Fig. 2.

With the Task at the centre and the Operator at the periphery, the ATT system is everything in between which enables the Operator to perform the Task remotely.

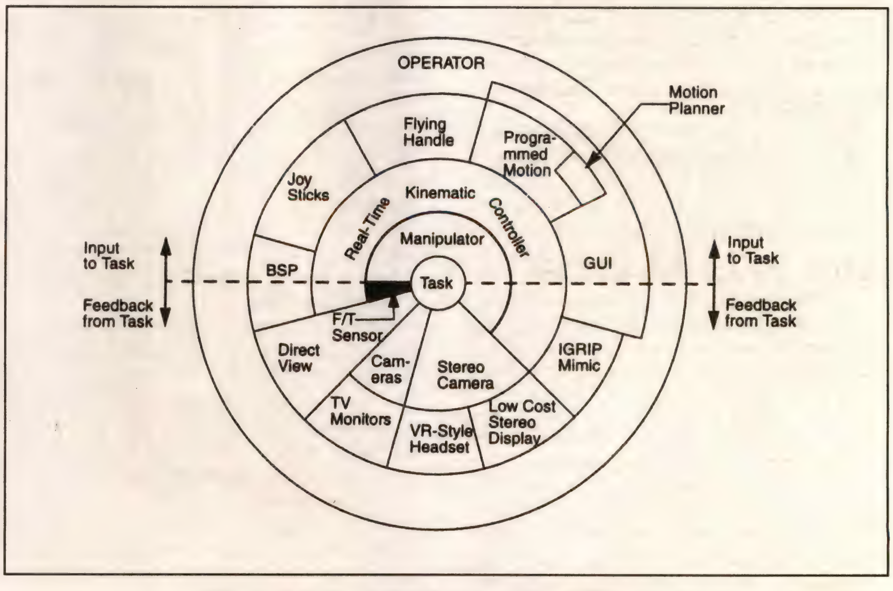


*Fig. 2. A task-centred view of the ATT system.*

The system consists of three layers which are effectively "transparent" to the operator, as is needed for a good task-centred system. A vertical line from the Task downwards to the Operator passes through an inner sector labelled Stereo Camera and an outer sector labelled VR-Style Headset. This is in the Feedback from Task hemisphere and indicates that the user can get a stereo visual image of the task he is performing, slaved to his head movements.

A line drawn from the Operator shows that inputs to the Task can be made using conventional joysticks, via the Real-time Kinematic Controller to the Manipulator that actually performs the Task.

The tasks to be achieved were defined in two representative mock-ups of nuclear plant: The first was electromechanical and had features that could be removed, avoided or swabbed. The second was an enclosed vessel that the manipulator could penetrate and was used for a variety of assembly and inspection tasks. Two vertical pipes were also used to restrict the workspace further so that the full effectiveness of the manipulator's dexterity could be tested.

## MANIPULATOR AND CONTROLLER

At the heart of the ATT system is the Manipulator, which is the primary means of remotely performing the task. The manipulator is a "Seven Degrees of Freedom" device. Normally, six parameters define the pose of the end-effector, or arm. The seventh DOF relates to the elbow roll angle, so increasing the arm's dexterity. The operator can adjust the manipulator's configuration by moving the elbow in an "orbit" around the wrist/shoulder line.

The Operator does not have direct access to the Manipulator but is passed through the Controller. This sends commands at the servo level via a shared memory interface that allows alteration of servo code parameters as well as passing joint commands.

Working at a higher level, the controller "cocoons" the manipulator, providing the Operator with enhanced functionality and an additional level of safety and robustness.

## MOTION PLANNER

The Motion Planner can be used to find a collision-free path, in joint space, that will move the manipulator between two specified points in a cluttered environment.

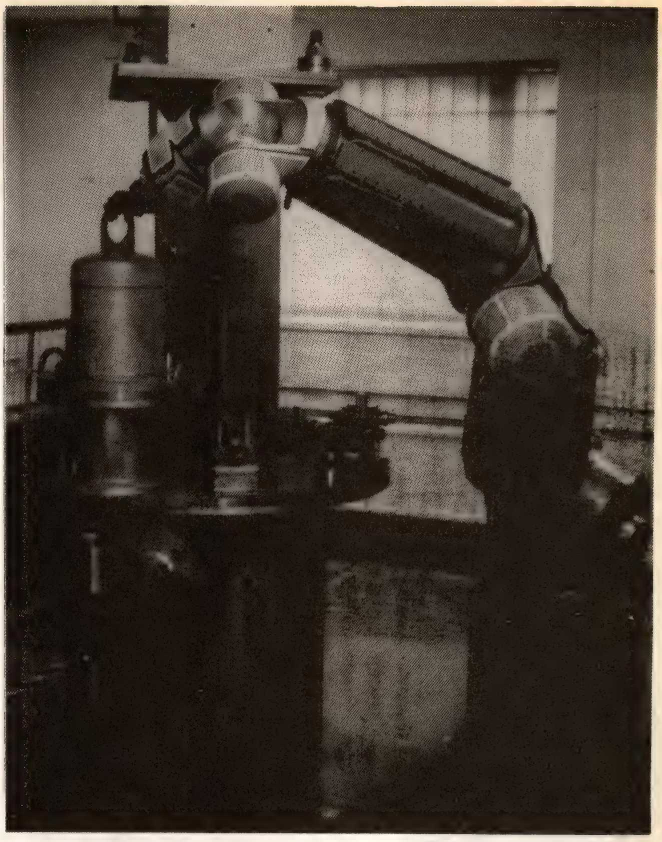
The remainder of the ATT system forms the Man/Machine Interface (MMI) which is split across three computer platforms. An accurate model of the manipulator and its workcell has been created in the IGRIP section – an exact kinematic representation of the real manipulator, including joint offsets and joint limits, which can be set to detect collisions or near misses between any objects in its workcell.

Teleoperation allows the user to remotely operate the manipulator with any one of three different input devices: joysticks, the "Flying Handle" or BSP.

The "Flying Handle" is a 6DOF spatial input device that uses Polhemus Fastrak magnetic field technology. The Fastrak sensor has been placed inside an InSys grip. With this device the operator commands linear and angular position using natural hand movements and the end-effector is slaved to the operator's hand motion.

BSP is a force-reflecting input device based upon a Bilateral Stewart Platform, and comprises a joystick mounted on a platform and attached to six actuated legs in a parallel configuration, plus a PC based controller.

Other teleoperation functions are provided, such as motion scaling, trajectory record and replay, and position recording. Moves may be made joint-by-joint or in a variety of resolved motion frames.



*UK Robotics' 7DOF remotely controlled arm is being evaluated by BNFL.*

## EXPANSION ANTICIPATED

After eight years of developing advanced robotics, the team is confident that it has arrived at a good telerobotic system that is both transparent and semi-autonomous, easy to learn and logically consistent. Geoff Pegman, UK Robotics' new MD, who was previously Engineering Manager of InSys, says he anticipates expansion of his company will be "fairly rapid".

"UK Robotics is largely product-based, yet is very different from any other robotics company in this country. Our core marketplaces are Europe and the US.

"Becoming a separate company emphatically does not mean we will be turning our back on research. It is vital we stay several steps ahead, so we have a continuing partnership with Edinburgh and Salford Universities, and with Professor Mike Brady at Oxford University Robotics Laboratory."

---

# LIBRIS BRITTANIA

Last month, the Public Domain Software Library (PDSL) were mentioned in connection with the software for the Simple PIC16C84 Programmer.

Over the past few years, PDSL has issued CD ROMs containing almost all the programs in its library called *"Libris Brittania"*, several thousands of them. Now the fifth edition of the work has been released in the form of a two-part set of CD ROMs, each of which comes in its own book with descriptive detail of each library program contained on the CD.

The first part CD is called *"The Scientific and Technical Library CD ROM"*. Subjects include Artificial Intelligence, Communications, Maths, Technical Drawing, Security Programming, Ham Radio and so on, and there are lots of utilities.

The second part CD is called *"The Business Software Library"* and contains 25 categories covering Business and Leisure programs.

Both parts sell individually at £29 each, or both CDs can be bought together at a discounted price of £49. VAT and postage are inclusive.

For further information, contact Susanne Lawrence, Public Domain and Software Library, Dept. *EPE*, Winscombe House, Beacon Road, Crowborough, Sussex TN6 1UL. Tel: 01892 663298.

---

# COMING-UP

***Sunday 4th Feb.*** The Lancastrian Rally, the north-west premier event for radio amateurs, computer and electronic specialists. At the University of Lancaster, doors open 10.30am. Tel: Sue Griffin, 01524 64239.

***Sunday 5th May.*** National Vintage Communications Fair, NEC, Birmingham. Open10.30am to 5pm. Tel: Jonathan Hill, 01398 331532.

# GONE-BY

Did you know that 100 years ago, Marconi arrived in Britain and took out the world's first patent for a workable system of wireless communication? Or that it's 60 years since the BBC introduced the world's first high-definition TV service from Alexandra Palace, London?

# MULTI-PURPOSE MINI AMPLIFIER

## ROBERT PENFOLD

*Low-budget, three input general purpose headphones amplifier.*

★ Radio Tuners ★ Cassette Decks
★ Guitar Pick-Ups ★ Microphones
★ General Testing and Fault Finding

THIS simple amplifier is primarily intended for use with the headphones supplied FREE with this issue of *Everyday Practical Electronics* (UK copies only), but it should work with any similar headphones. In other words, any medium impedance headphones of the type generally sold as replacements for personal stereo units.

This amplifier is intended to be a general purpose type which will operate properly with most signal sources. It has three inputs which provide widely differing levels of sensitivity. The High Level input is for use with signal sources such as Tuners, Cassette Decks, etc., which provide signal levels of at least 100mV r.m.s.

The Medium level input is primarily for use with Guitar pick-ups, but it might be usable with other signal sources. It requires an input level of only around 10mV r.m.s. The Low level input is extremely sensitive, and it will provide good volume from signal sources such as high or low impedance Dynamic Microphones, Electret Microphones, and very low output Guitar pick-ups.

Obviously this amplifier can be used for a specific task, such as a Guitar Practice Amplifier, but it is primarily intended for use as a general purpose test amplifier. As such, it only drives the headphones monophonically, but there should be no difficulty in building a *stereo* version of the amplifier. This just entails building *two* amplifier boards, one to drive each earphone.

### CIRCUIT DESCRIPTION

The full circuit diagram for the Multi-Purpose Mini Amplifier is shown in Fig. 1. This breaks down into two main sections, which are a preamplifier stage based on IC1 and a small power amplifier built around IC2. Potentiometer VR1 is the Volume control, and it is used in the coupling between the two stages.

An operational amplifier, IC1, is utilized here in the inverting mode. Resistors R4 and R5 provide a bias voltage of about half the supply potential to the non-inverting input, pin 3, of IC1. C5 is a decoupling capacitor, and its purpose is to avoid feedback through the power supply lines.

This feedback can occur due to variations in the supply current loading the battery, and causing variations in the supply voltage. Supply decoupling capacitor C1 also helps to minimise any stray feedback via this route.

### INPUTS

The gain and input impedance of the preamplifier is determined by two resistors which form a negative feedback network. Resistor R6 always provides one section of the negative feedback network, but the other section is formed by resistor R1, R2, or R3, depending on which input is in use.

With Input One in use, the two negative feedback resistors are R1 and R6. The input impedance of the circuit is equal to the value of the input resistor, which is R1 in this case. The circuit therefore has an input impedance of 10k (kilohms) at Input One.

Calculating the voltage gain of an inverting mode circuit is very straightforward, and in this case the gain is equal to the value of R6 divided by the value of the input resistor. This works out at 1000k (1M) divided by 10k, which is obviously 100 times.

This relatively high gain gives the circuit high sensitivity when Input One is used, but with an input impedance that is not particularly high. This gives input characteristics that are well suited to many types of microphone, and to very low output guitar pick-ups.

Resistor R2 becomes the input section of the negative feedback network with Input Two in use. This has a value that is ten times higher than that of R1, which gives a higher input impedance of 100k, but provides a lower voltage gain from IC1.

In fact, the voltage gain is reduced to just 10 times. This still gives quite good sensitivity, and this input is well suited to use

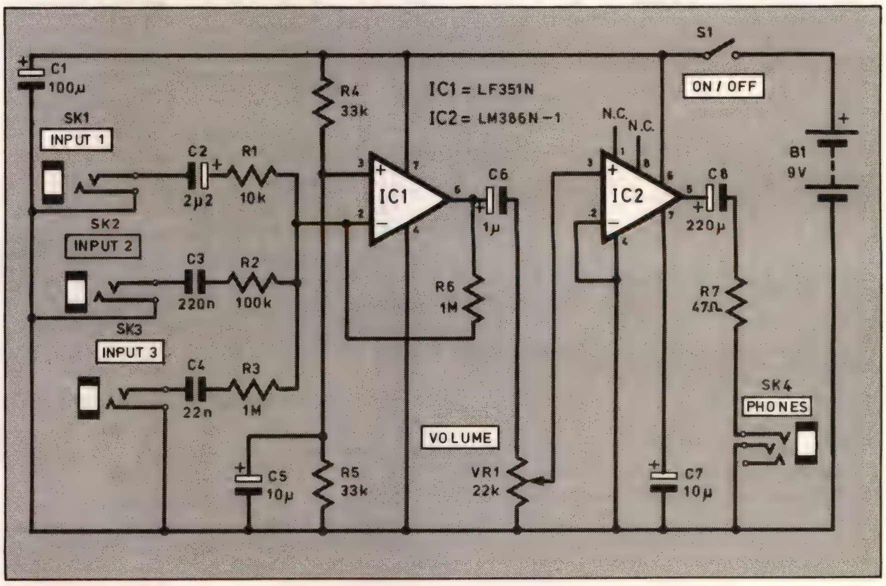


*Fig. 1. Full circuit diagram for the Multi-Purpose Mini Amplifier.*

with most guitar pick-ups, older hi-fi equipment which has a relatively low output level, etc.

With Input Three in use, R3 acts as the input resistor. Its value is 10 times higher than that of R2, giving another tenfold increase in the input impedance, but also a tenfold reduction in the voltage gain provided by IC1.

In other words, the input impedance is one megohm and the voltage gain is unity. IC1 really just acts as a buffer amplifier when Input Three is in use.

This input gives low sensitivity, but it is well suited to use with most tuners, cassette decks, compact disc players, etc. It is also suitable for use with very high output guitar pick-ups, which might produce overloading and an unwanted "fuzz" effect if used with Input Two! Due to its high input impedance, this input is also suitable for use with crystal and ceramic pick-ups.

## POWER AMPLIFIER

Electrolytic capacitor C6 couples the output signal from the preamplifier stage IC1 to the Volume control, which has its wiper (moving contact) directly coupled to the non-inverting input, pin 3, of IC2. This is an LM386-1, which is a small audio power amplifier i.c. having a class B output stage. No coupling capacitor is needed at the input of IC2 as this chip is designed for direct connection to a Volume control.

The inverting input at pin 2 of IC2 is not required in this circuit, and this pin is connected to the 0V supply rail to avoid stray pick-up. Capacitor C7 provides supply decoupling to the input stage of IC2.

The voltage gain of IC2 can be boosted somewhat by connecting a capacitor between pins one and eight, but for the present application the basic voltage amplification of IC2 is perfectly adequate. Consequently, pins one and eight are left unconnected.

## OUTPUT

Capacitor C8 provides d.c. blocking at the output, and resistor R7 provides a certain amount of attenuation in conjunction with the impedance of the headphones. The sensitivity of medium impedance headphones varies considerably, but in general the "inner-ear" variety have higher sensitivity than the conventional type.

The direct output of IC2 is slightly excessive for conventional medium impedance headphones, and is much too strong for most inner ear types. R7 provides sufficient attenuation to prevent grossly excessive volume levels with the FREE *EPE* headphones, but it is still possible to obtain high volume levels if desired.

If the amplifier is used with sensitive inner-ear headphones it would be preferable to use a higher value for R7. A value of about 220 ohms should give safe results but still permit good volume levels to be obtained.

The quiescent supply current of the circuit is approximately 5mA, but the current drain rises significantly when the amplifier is used at high volume levels. A PP3 size battery is adequate to power the unit, but six HP7 size cells in a holder are a better choice if the unit is likely to be used for long periods.

## CONSTRUCTION

The Multi-Purpose Mini Amplifier is built on a small printed circuit board

(p.c.b.) and housed in a two-tone, medium size case, with aluminium front and rear panels. The printed circuit board is available from the *EPE PCB Service*, code 976.

Details of the topside p.c.b. component layout and interwiring to off-board components are provided in Fig. 2. The actual size copper foil master pattern for the printed circuit board is also included separately.

Neither of the integrated circuits are static sensitive, but it is advisable to fit them in holders anyway. Be careful to fit both i.c.s and the six electrolytic capacitors the right way round.

The electrolytics must be miniature radial types if they are to fit neatly onto the board. C3 and C4 should be printed circuit mounting types having a lead spacing of 7·5mm (0·3 inches).

Fit single-sided solderpins to the board at the points where connections to the controls and sockets will be made. One millimetre diameter pins are required. The tops of the pins should be "tinned" with a generous amount of solder, which will make it easy to make reliable connections to them.

The unit should fit into practically any medium size metal or plastic case. With any piece of sensitive audio equipment there is an advantage in using a metal case, as it screens the circuit board and wiring from sources of mains "hum" and other sources of electrical noise. However, it is not essential, and with this project there is a slight complication if a metal case is used.

## INSULATED SOCKETS

Because the stereo headphones are driven monophonically, no connection is made to the "earth" tag of the output

## COMPONENTS

**See SHOP TALK Page**

**Resistors**

| | |
|---|---|
| R1 | 10k |
| R2 | 100k |
| R3,R6 | 1M (2 off) |
| R4,R5 | 33k (2 off) |
| R7 | 47Ω (see text) |

All 0·25W 5% carbon film

**Capacitors**

| | |
|---|---|
| C1 | 100µ radial elect. 10V |
| C2 | 2µ2 radial elect. 50V |
| C3 | 220n polyester, p.c.b. mounting with 7·5mm lead spacing |
| C4 | 22n polyester, p.c.b. mounting with 7·5mm lead spacing |
| C5,C7 | 10µ radial elect. 25V (2 off) |
| C6 | 1µ radial elect. 50V |
| C8 | 220µ radial elect. 10V |

**Semiconductors**

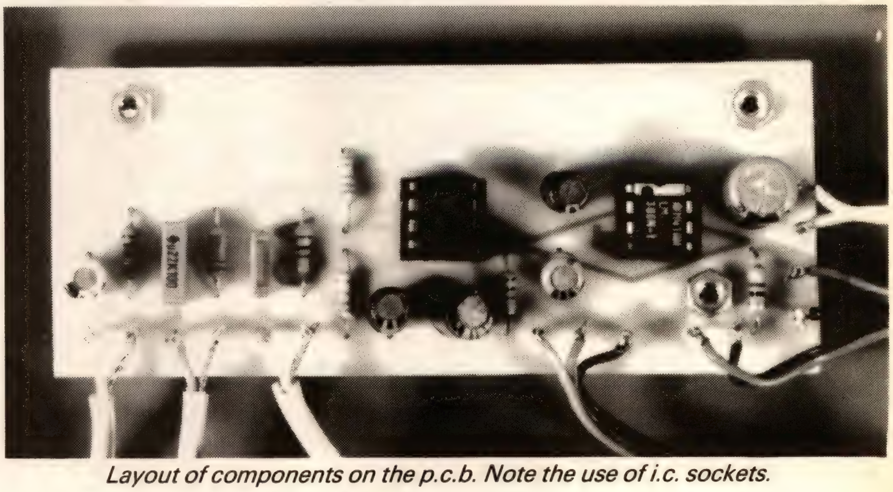
| | |
|---|---|
| IC1 | LF351N Bifet op.amp |
| IC2 | LM386N-1 325mW audio power amp |

**Miscellaneous**

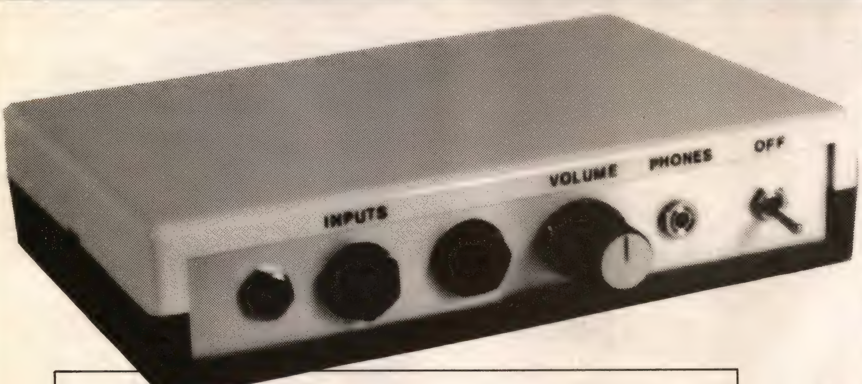
| | |
|---|---|
| SK1 | 3·5mm jack socket |
| SK2, SK3 | Standard 6·35mm jack socket (2 off) |
| SK4 | 3·5mm stereo jack socket |
| S1 | s.p.s.t. min toggle switch |
| B1 | 9V battery (PP3 size or 6 x HP7 pack) |

Printed circuit board available from *EPE PCB Service*, code 976; plastic or metal case about 180mm x 120mm x 41mm; battery connector; 8-pin d.i.l. holder (2 off), control knob, solder pins, multistrand connecting wire, solder, etc.

*Approx cost guidance only* **£12** *excluding case*



*Layout of components on the p.c.b. Note the use of i.c. sockets.*



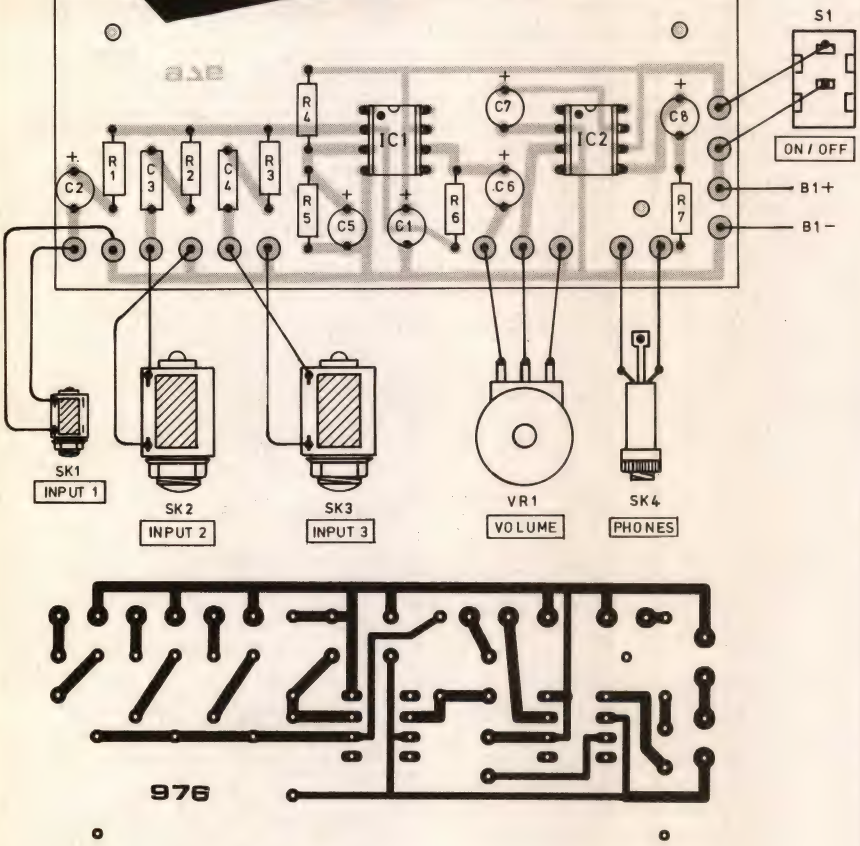
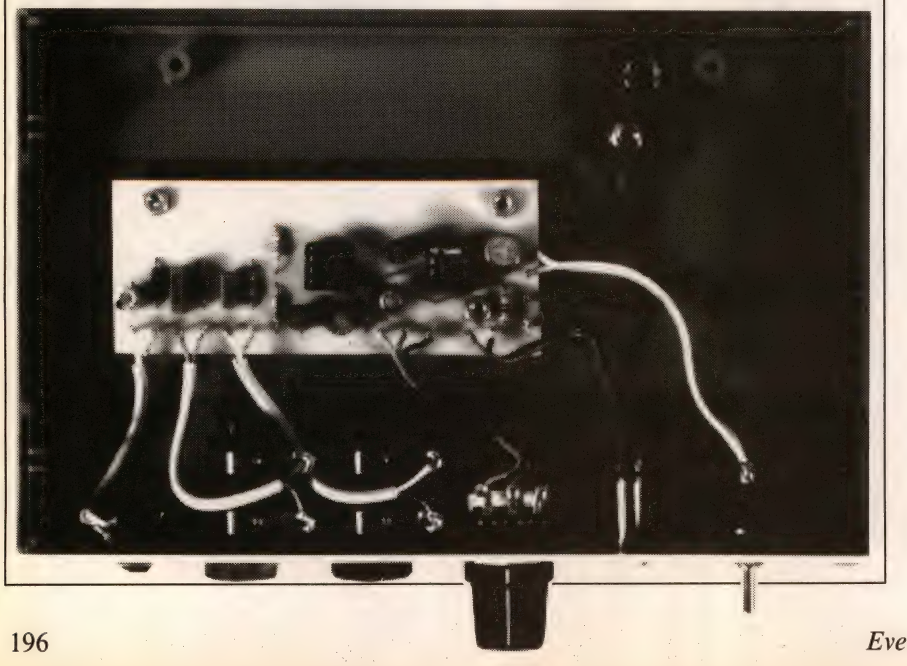


*Fig. 2. Mini Amplifier printed circuit board component layout, off-board component interwiring and full size foil master. The completed amplifier showing wiring can be seen below.*



socket SK4. The two output terminals of the amplifier connect to the two *non-earth* tags of SK4, and the headphones are then driven in series. Driving the phones in parallel would in some ways be more satisfactory, but would also be very inefficient, and would give poor battery life.

The problem with using a metal case is that many sockets have their earth tags connected *internally* directly to their mounting bushes. This provides connections between the earth tags via the case.

In this instance these connections can provide an unwanted connection to the earth tag of the output socket. This places a short circuit across one of the earphones, effectively rendering it inoperative.

The easy way around the problem is to use an insulated jack for output socket SK4, or to use insulated input sockets (SK1 to SK3). The prototype amplifier is housed in a plastic case having metal front and rear panels. Socket SK1 is an insulated 3.5mm jack socket, and SK2 plus SK3 are insulated standard (6·35mm) jacks.

Insulated jack sockets often have extra tags which connect to built-in switch contacts. These switches serve no useful purpose in this application, and any extra tags are simply ignored.

If you wish to use open (non-insulated) sockets the unit should be housed in a *plastic* case, so that the unwanted earth connection is avoided. The amplifier should then be operated where it is well clear of any strong sources of electrical noise, such as television sets and computer systems.

## INTERWIRING AND LAYOUT

The general layout of the unit is not critical, but try to keep the input sockets reasonably well separated from the output socket. Also, keep the input wiring well separated from the output lead to SK4. This helps to avoid problems with instability due to stray feedback.

The printed circuit board is mounted in the case using 6BA or metric M3 fixings, including spacers about 6mm long. Fig. 2 shows the hard wiring, which is mainly straightforward.

It is not essential to use screened cable for the connections from the input sockets to the circuit board, but doing so helps to minimise any stray pick-up of electrical noise, particularly if a plastic case is used. It also reduces the risk of stray feedback and instability.

## IN USE

If the unit is functioning correctly, with the Volume control well advanced there should be plenty of "hum" and other noise from the headphones if the non-earth tags of any of the input sockets are touched. If there is a lack of response from the unit, switch off immediately and recheck all the wiring.

The best input for a given signal source can be determined by trial and error. A more sensitive input must be used if it is not possible to obtain a high enough volume level. Clipping and severe distortion on the output signal will be evident if the input signal overloads the preamplifier stage. A less sensitive input should then be used. Remember that Input 1 is the most sensitive, and Input 3 has the lowest sensitivity. □

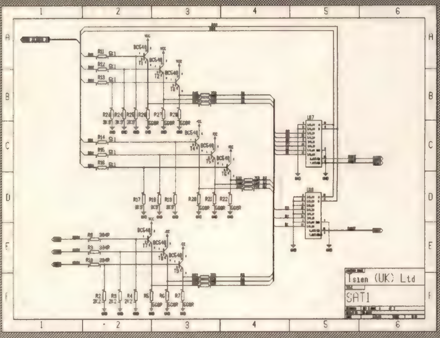
# Is your PCB design package not quite as "professional" as you thought? Substantial trade-in discounts still available.

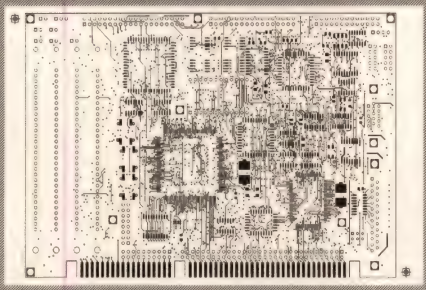
## BoardCapture

*Schematic Capture Design Tool*

**£395**

- Direct netlist link to BoardMaker2
- Forward annotation with part values
- Full undo/redo facility (50 operations)
- Single-sheet, multi-paged and hierarchical designs
- Smooth scrolling
- Intelligent wires (automatic junctions)
- Dynamic connectivity information
- Automatic on-line annotation
- Integrated on-the-fly library editor
- Context sensitive editing
- Extensive component-based power control
- Back annotation from BoardMaker2





## BoardMaker

*BoardMaker1 - Entry level*

**£95**

- PCB and schematic drafting
- Easy and intuitive to use
- Surface mount and metric support
- 90, 45 and curved track corners
- Ground plane fill
- Copper highlight and clearance checking

*BoardMaker2 - Advanced level*

**£395**

- All the features of BoardMaker1
- Full netlist support- BoardCapture, OrCad, Schema, Tango, CadStar
- Full Design Rule Checking both mechanical and electrical
- Top down modification from the schematic
- Component renumber with back annotation
- Report generator- Database ASCII, BOM
- Thermal power plane support with full DRC

## BoardRouter

*Gridless re-entrant autorouter*

**£200**

- Simultaneous multi-layer routing
- SMD and analogue support
- Full interrupt, resume, pan and zoom while routing

*Output drivers - Included as standard*

- Printers - 9 & 24 pin Dot matrix, HPLaserjet and PostScript
- Penplotters - HP, Graphtec & Houston
- Photoplotters - All Gerber 3X00 and 4X00
- Excellon NC Drill and Annotated drill drawings (BM2)

*For futher information contact*
*Tsien (UK) Limited*
*Aylesby House*
*Wenny Road, Chatteris*
*Cambridge, PE16 6UT*
*Tel 01354 695959*
*Fax 01354 695957*
*E-mail Sales@tsien.demon.co.uk*

tsien

All trademarks acknowledged

# New Technology Update

*Ian Poole casts his eyes over the problems of producing 3D images and discovers that the age of the 3D Surgeon is not too far off.*

ENTERTAINMENT plays a large part in our society today, and ever since the first radio broadcasts, people have been seeking to make entertainment in the home more realistic. High quality audio transmissions were introduced using v.h.f. f.m. in the 1950s and this was followed by stereo.

Television arrived and then it was improved in the UK by increasing the definition from 405 lines to 625 lines. Colour was also introduced shortly afterwards. All of these are now standard items in most homes, but with technology pressing forwards wide screens and a host of other developments are on the horizon.

## 3D Images

One idea which has always been of interest is the display of three dimensional (3D) images. This is the ultimate in reality where the image could be suspended in mid-air and it would even be possible to see behind the displayed object.

True 3D images can be displayed using holograms, but the technology has not been developed to a stage where it is viable for the home, and certainly not for broadcast transmission.

Despite this, many companies are developing various forms of flat 3D displays, bringing three dimensional television a step closer. Most of the early attempts at creating a 3D image revolved around the use of spectacles with two lenses having different colours or polarisations. The two images can then be displayed together on the screen, leaving the spectacles to filter out the right and left images.

These systems have been used on a number of occasions. Recently the BBC transmitted a few programmes using this method. The spectacles were sold in the shops with the proceeds going to charity.

Obviously, systems like these lack the full reality of a true 3D system, and this is why they are not widely used. However, many developments are taking place with the ultimate aim of being able to display proper images.

## Head Start

The main idea behind systems for creating a stereo image is to be able to send two slightly different images to each eye. There are naturally a number of different ways of achieving this. One method which is starting to appear in a number of forms is to generate two images and ensure that one reaches the left eye and the other reaches the right one.

To ensure this happens, a knowledge of the position of the viewer is needed. In one system developed by the University of Dresden, this is aptly called a "head finder".

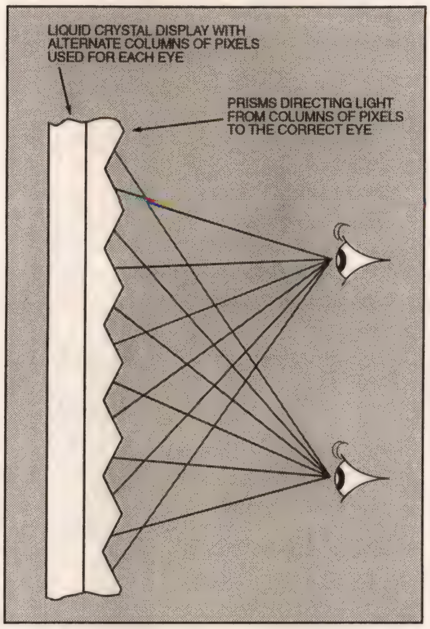

LIQUID CRYSTAL DISPLAY WITH ALTERNATE COLUMNS OF PIXELS USED FOR EACH EYE
PRISMS DIRECTING LIGHT FROM COLUMNS OF PIXELS TO THE CORRECT EYE

*Fig. 1. Prisms used to direct the correct image to each eye.*

The equipment consists of a camera from which the information is image processed to give a knowledge of the angle and hence the position of the head. The two viewing fields are then adjusted to give the correct images for the viewer to see the "stereoscopic" image. A very similar positioning system is also used in the second system developed by Sharp's Oxford research laboratories.

## Two Views

The major areas of development are in generating the two images together. The two images required for the Dresden system are created on one liquid crystal display (l.c.d.). Odd columns of pixels display the image for the left eye and the even columns give the right eye picture.

The crucial part of the system lies in the collimator. This consists of a series of prisms, each one allocated to a specific pixel column. These direct the light in the direction of the respective eye as shown in Fig. 1.

Production of the prism is the key to the success of the project. It is manufactured by coating a sheet of glass with an ultraviolet sensitive varnish. A master prism is used to imprint the correct shape into the varnish which is then hardened and the master prism removed.

The Sharp system uses two l.c.d. panels placed at right angles to one another as shown in Fig. 2. A half silvered mirror placed at an angle of 45 degrees between acts as a combiner.

Positioning of the image so that it is seen by the correct eye is undertaken by placing a specialised light source behind the liquid crystal display. By controlling the effective position of this the light is directed towards the correct eye and away from the other

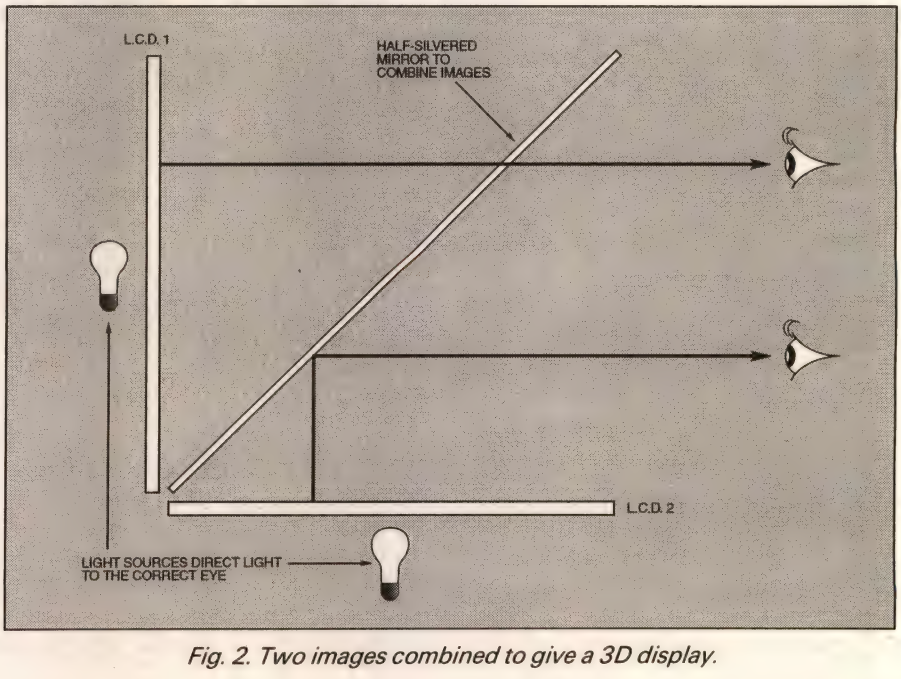

L.C.D. 1
HALF-SILVERED MIRROR TO COMBINE IMAGES
L.C.D. 2
LIGHT SOURCES DIRECT LIGHT TO THE CORRECT EYE

*Fig. 2. Two images combined to give a 3D display.*

one. In this way only one image is seen by each eye.

One of the advantages of the Dresden system is that the whole display is anticipated to be only about 60 per cent more expensive than an existing one. The l.c.d. uses existing technology, and the prism can be manufactured relatively cheaply.

The display itself is still not finalised, requiring additional work on the head positioning and movement. However, it is sufficiently advanced for initial production.

## In Reality

There are many uses for 3D display systems. Many CAD systems now cater for 3D images, being able to rotate them and give views of how different parts fit together.

The main problem is that these images are usually displayed on a standard two dimensional cathode ray display. If these images could be displayed three dimensionally it would enable the designer to use the system more effectively.

Apart from CAD applications there are many other areas where a 3D display would be an advantage. Video games is one of the first areas which springs to mind. Here there is a vast market which would be very keen to employ a new technique to bring more reality to the games.

## 3D Surgeons

Another area where three dimensional displays may be very important is within remote control applications. In the press, the idea of surgeons performing operations over a remote link with very specialised robot arms has been developed. Currently the arms have been built and in themselves they are a revolutionary development being capable of very fine movements and giving a sense of feel at the controlling end.

To be able to perform operations of this nature satisfactorily surgeons must have the most realistic feedback possible, making them feel that they are actually at the remote site performing the operation. Another way of improving this is to give a three dimensional display. This would give a more realistic impression of depth, enabling the operation to be carried out more successfully.

Whilst this may seem a far fetched idea today, it may be a life saving technique, enabling the top surgeons to perform operations all over the world without having to spend valuable time in travelling.

It has also been suggested that it would be very valuable in war scenarios. The remote operating theatre could be set up in the war zone so that the wounded could be brought in quickly and easily. The surgeon with the relevant experience and located in a safe area could then be used for the operation.

With the computer and electronics world progressing towards making more life-like representations of visual images it is certain that at least some of the ideas for three dimensional displays will be taken up. Those which have little cost increase over the two dimensional ones are likely to have an excellent chance of being widely used, even if there are a number of limitations.

---

# Ohm Sweet Ohm

## *Max Fidling*

### *Mog-nificent*

I just knew it was going to be one of those days! I could tell when I accidentally kicked the bowl of cat food all over the kitchen floor, thereby incurring a filthy look from the Boss, not to mention the usual quizzical look from my beloved moggie, Piddles.

From experience, I knew when it was time to beat a hasty retreat to the workshop, so I ambled into my shack in the back garden, to leave the Boss clearing up a tin-full of Whiskas, ably assisted by the cat who tackled the Max-induced spillage with gusto!

On the bench was a copy of a recent electronics magazine and I'd decided to whittle away my time by having a bash at building one of the featured projects. My latest brainchild was gradually emerging on the bench – a small battery-operated thermostatic alarm which I was in the process of adapting to warn of low temperatures in the attic.

### *Frigid Fidlings*

You see, in the recent wintry weather, the Fidling household had had more than its fair share of domestic disasters as we bravely huddled together inside, trying not to succumb to the icy fingers of the Arctic weather which had reached across from Siberia and were gradually getting a stranglehold grip on the British Isles (as it said on the telly). The frozen weather had resulted in a burst pipe in the attic, and water had started to trickle through, of all places, an upstairs light switch!

Now, to have the Niagara Falls dribbling through a 230V wall switch is not the happiest way to enjoy life intact, and yours truly, intrepid as ever and fearing nothing, had received his orders to investigate the cause of this unexpected deluge. I switched off all the electrical supplies at the fusebox, thereby blanking out the lights not to mention the telly, which the Boss had been watching avidly at the time.

### *Chill Out*

Fumbling around in the garage, I eventually stumbled across my Woolworth's plastic torch which I always kept for such emergencies. The lantern flickered into life. Back inside, I gingerly clambered up a teetering step-ladder and into the attic, rather in the manner that a certain moggie stalked meeces in the garden.

The plumbing in the attic still bore the signs of my earlier attempts to repair it. The overflow had previously leaked and this had done interesting things to the ceiling, such as creating rusty brown stains in the white emulsion. Furthermore, on at least one occasion I'd managed to stick my foot right through the plasterboard and hence I'd had to re-decorate the whole lot!

So this time, I trod very cautiously, like a sapper in a minefield. I soon spotted the cause of the burst pipe: amongst all the fleecy if rather horrid loft insulation, I could see a thin trickle of water stemming from a small split in a copper pipe. The pipe had obviously frozen solid during the recent icy snap and this had split the pipe. Only when the weather had perked up a little had the ice thawed and now water was winging its way ceiling-wards, much to our horror!

In fact, the water had been running along the ceiling until it found a piece of electrical conduit standing proudly upwards. Down into the conduit ran an electric light cable, and the conduit terminated in . . . a light switch! So the escaping water had managed to navigate around the attic and was trickling down the conduit and downstairs through a switch below!

### *Bog-standard Bodging*

Not being one to spend money unnecessarily, I was determined to impress the Boss with my D.I.Y. skills once more! Who needs plumbers anyway?

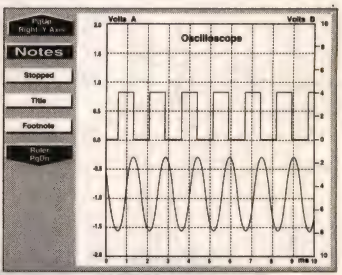
There was only one thing for it – I scampered back downstairs and out into the workshop. I stumbled upstairs again with my trusty toolbox plus a large bag of cat litter. I reckoned the cat litter would be useful for soaking up, erm, excess liquid spillage other than its intended application, so in the murky gloom I sprinkled handfuls of the stuff onto the pools of water on the attic floor, with a view to hoovering it up later. What a neat idea!

I had a large reel of gaffer tape which I started to wrap around the burst pipe, which by now had slowed to a drip. So a goodly-bodged repair should be OK until warmer weather allowed a more expert approach. It seemed to work a treat!

Then I suddenly realised: there was a good chance that the cat litter I'd been showering around the attic may actually be *used* litter, since the Boss had a habit of putting the old stuff into a big bag, and keeping it near the bin ready for disposal . . . Nobody knows to this day! (About the gaffer tape, I mean, what else?)

# Pico Releases PC Potential

**Pico's Virtual Instrumentation enable you to use your computer as a variety of useful test and measurement instruments or as an advanced data logger.**

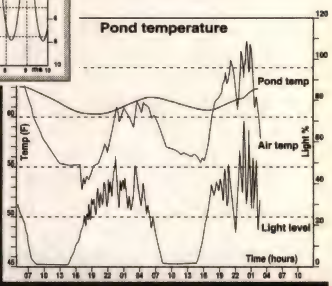


**PicoScope**
'Virtual instrument' software.

Hardware and software are supplied together as a package - no more worries about incompatibility or complex set-up procedures. Unlike traditional 'plug in' data acquisition cards, they simply plug into the PC's parallel or serial port, making them ideal for use with portable PC's.

***Call for your Guide on 'Virtual Instrumentation'.***

**PicoLog**
Advanced data logging software.



## *NEW from Pico TC-08* Thermocouple to PC Converter

**8 channel Thermocouple Interface**

- **Connects to your serial port - no power supply required.**
- **Supplied with PicoLog datalogging software** for advanced temperature processing, min/max detection and alarm.
- **8 Thermocouple inputs (B,E,J,K,N,R,S and T types)**
- **Resolution and accuracy dependant on thermocouple type.** For type K the resolution is better than 0.1°C .

***TC-08*** **£ 199**
***TC-08*** + Calibration Certificate **£ 224**

complete with PicoLog, software drivers and connecting cable.
A range of thermocouple probes is available.

## *SLA-16 & SLA-32* Logic Analysers

**Pocket sized 16/32 channel Logic Analysers**

- **Connects to PC serial port.**
- **Up to 50MHz sampling.**
- **Internal and external clock modes.**
- **8K Trace Buffer.**

*SLA-16* £ 219
*SLA-32* £ 349
with software, power supply and cables

## *ADC-100* Virtual Instrument

**Dual Channel 12 bit resolution**

- **Digital Storage Scope**
- **Spectrum Analyser**
- **Frequency Meter**
- **Chart Recorder**
- **Data Logger**
- **Voltmeter**

The ADC-100 offers both a high sampling rate (100kHz) and a high resolution. It is ideal as a general purpose test instrument either in the lab or in the field. Flexible input ranges (±200mV to ±20V) allows the unit to connect directly to a wide variety of signals.

*ADC-100* with PicoScope **£199**
with PicoScope & PicoLog **£219**

*ADC-10*
**1 Channel 8 bit**

- Lowest cost in the Pico range
- Up to 22kHz sampling
- 0 -5V input range

The ADC-10 gives your computer a single channel of analog input. Simply plug into the parallel port.

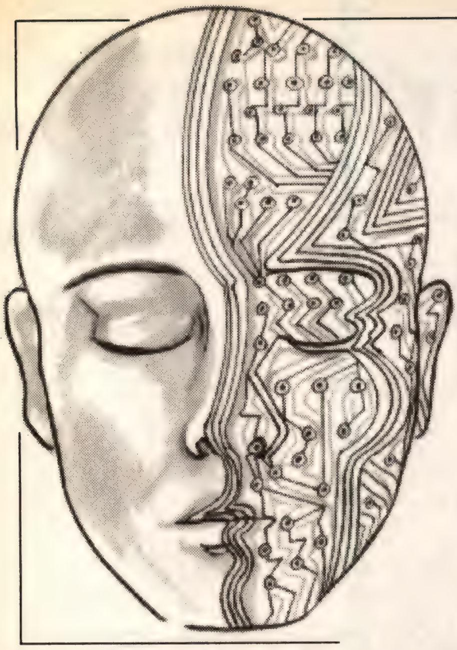
***ADC-10* with PicoScope £49**
**PicoScope & PicoLog £59**

Carriage UK **free**, Overseas **£9** Oscilloscope Probes ( x1, x10 ) **£10**

**PICO TECHNOLOGY**

**Pico Technology Ltd. Broadway House, 149-151 St Neots Rd, Hardwick, Cambridge. CB3 7QJ**
**Tel: (0)1954 - 211716 Fax: (0)1954 - 211880 E-mail: 100073.2365 @compuserve.com**

Phone or FAX for sales, ordering information, data sheets, technical support. All prices exclusive of VAT



# INGENUITY UNLIMITED

Our regular round-up of readers' own circuits. We pay between £10-£50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit tips, not simply mechanical or electrical ideas. Ideas *must be the reader's own work* and **not have been submitted for publication elsewhere.** The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should preferably be typed or word-processed, with a brief circuit description showing all relevant component values. Please draw all circuit schematics as clearly as possible.

Send your circuit ideas to: Alan Winstanley, *Ingenuity Unlimited,* Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF. They could earn you some real cash!

## Rain sensor – banish washday blues!

ORIGINALLY designed to generate a warning sound when it started raining, Fig. 1 shows a simple Rain Sensor design which incorporates pitch and volume controls in the alarm signal. Whenever the sensor is bridged by droplets of water, the Darlington transistor TR1/TR2 will conduct.

This enables IC1, a 555 astable tone generator, to function, powering a small loudspeaker through a driver transistor TR3. VR2 determines the pitch of the audio tone which can be anything from about 25Hz to 18kHz, whilst VR3 adjusts the volume.

The sensitivity of the circuit is set by VR1. The Darlington pair could be constructed with two separate ZTX300s or a single TIP122. For the sensor itself, I used a small piece of stripboard, linking alternate strips into an interlocking design. The circuit will operate from a standard 9V PP3-type battery.

***M.R.L. Chapman,***
***Rogate, Hampshire.***

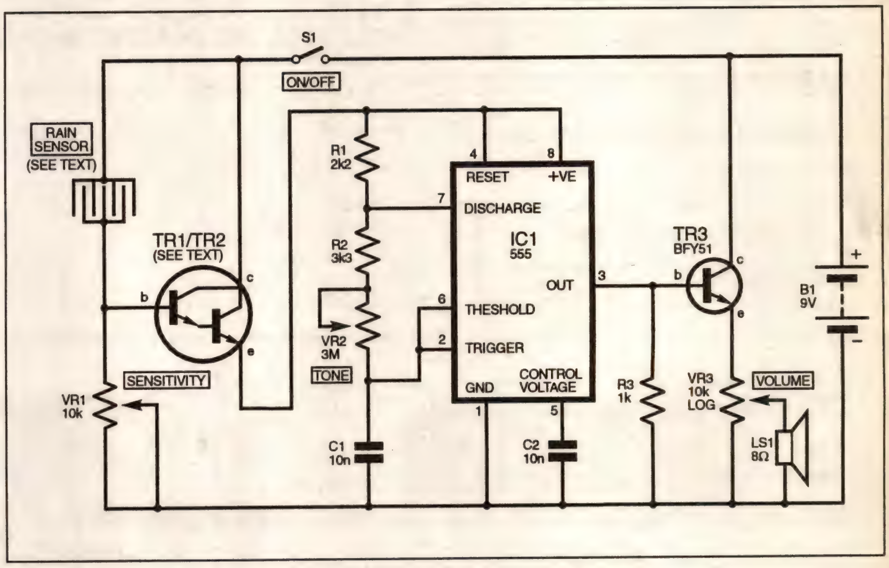


*Fig. 1. Circuit diagram for a simple Rain Sensor.*

## High Gain Transistor Amplifier – turn it up

THE high gain inverting amplifier stage illustrated in Fig. 2 was developed for use as part of a tone control circuit. The stage was designed to operate with a rail of between 3V to 30V. It includes a bootstrap network (R1, C2) which serves to increase the gain of the stage to approximately 3,000 as well as offering a low distortion output waveform at maximum amplitudes.

The input impedance is approximately 80 kilohms at 200Hz., the output level is 80% at 20kHz and noise at the output is 14mV peak-to-peak. R5 and D1 were included to proportionately lower the bias to TR1 to compensate for any increases in the rail voltage; R5 may be omitted and D1 shorted out if the rail is constant.

With a supply rail of 30V the author found that the best quality of output was obtained with the d.c. output level set to 16·5V, which gave a maximum output swing of 24V peak-to-peak. VR1 is adjusted to give symmetrical clipping of the maximum output signal.

***M. Richardson,***
***New Malden, Surrey.***

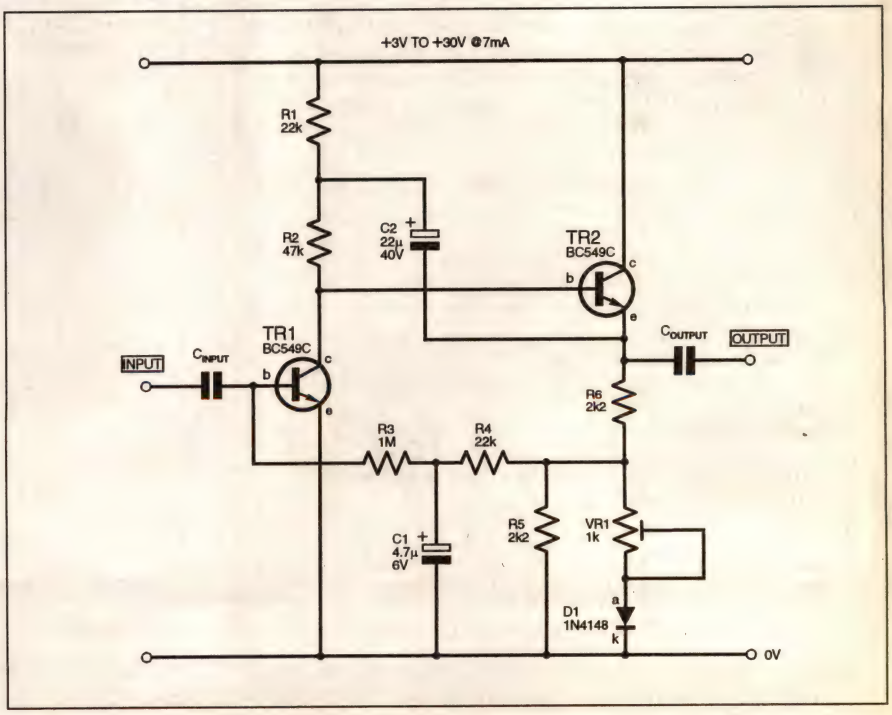


*Fig. 2. Circuit diagram for a high gain transistor amplifier stage.*

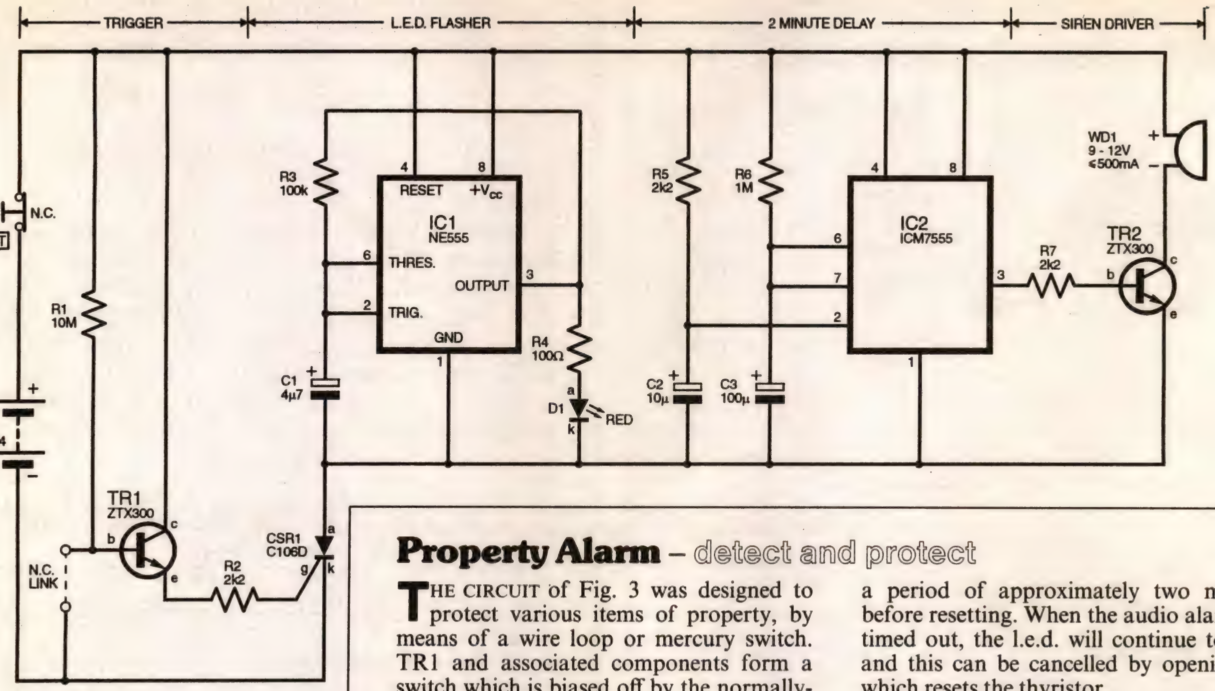


*Fig. 3. Circuit diagram for a Property Alarm.*

## Property Alarm – detect and protect

The circuit of Fig. 3 was designed to protect various items of property, by means of a wire loop or mercury switch. TR1 and associated components form a switch which is biased off by the normally-closed (N.C.) link.

When the link is broken, TR1 conducts and triggers the thyristor CSR1 into conduction. Consequently, the l.e.d. flasher centred around the 555 astable of IC1, causes D1 to blink.

Additionally, IC2 is a monostable timer which triggers through R5/C2 and drives an audible warning device via TR2 for a period of approximately two minutes before resetting. When the audio alarm has timed out, the l.e.d. will continue to flash and this can be cancelled by opening S1, which resets the thyristor.

The quiescent current of the circuit is very low due to the high value of resistor R1. A mercury switch can be used in place of the wire link to act as an anti-tamper alarm, in which case care must be taken to avoid accidental contact with the mercury bead itself since it is highly toxic.

*S.M. Spencer,*
*Sleaford, Lincs.*

**NEXT MONTH**
**CIRCUIT SURGERY**

**BTEC Certificated**

**TUTOR Supported**

NATIONAL
COLLEGE OF
TECHNOLOGY

**DISTANCE LEARNING COURSES**

The National College of Technology offer a range of packaged learning short courses for study at home or in an industrial training environment which carry modular BTEC awards leading to a higher BTEC certificate. Study can commence at any time and at any level enabling you to create a study routine to fit around existing commitments. Courses on offer include:

**Analogue Electronics**
**Digital Electronics**
**Fibre/Optoelectronics**
**Mechanics & Mechanisms**
**Programmable Logic Controllers**
**Electronic Testing & Fault Diagnosis**

Tutor support and BTEC certification are available as options with no travelling or college attendance required. These very popular courses which are ideal for vocational training contain workbooks, audio cassette lecturettes, PCB's, instruments, tools, components and leads as necessary to support the theoretical and practical training. Whether you are a newcomer to electronics or have some experience and simply need an update or certification, there is probably a distance learning course ready for you. Write or telephone for details to:

**National College of Technology**
**NCT Ltd., PO Box 11**
**Wendover, Bucks**
**Tel: (01296) 624270**

**READ BARCODES FOR £19.00**

**HEWLETT PACKARD HP71B**
**As easy to use as a calculator but as powerful as a computer**

**BARCODE READER**
**Smart wand**

**– Automatically recognises and decodes all major bar-code standards.**

**NEW LOWER PRICE**

- A powerful set of basic functions, statements, and operators – over 230 in all – many larger computers don't have a set of basic instructions this complete.
- Advanced statistics functions enabling computations on up to 15 independent variables.
- Recursive subprograms and user defined functions.
- An advanced internal file system for storing programs and data – The HP71 has continuous memory – when you turn the computer off it retains programs and data.
- A keyboard that can be easily customised for your specific application.
- HP-1L Interface pre-installed to create a system that can print, plot, store, retrieve and display information. Control or read instruments or speak to other computers, 5000 bytes/sec. Built in ROM includes 46 separate commands, Interface to HP-1L, HP-1B, RS232C, GPIO or series 80. Includes connection cables.

These are second users systems, ex NHS, are fully tested and working but have no programming (THAT IS UP TO YOU).

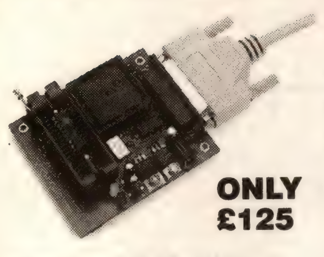
Complete kit of HP71B, Bar-code Reader, Memory Module and power supply.................................**£19.00** + VAT

We accept Access and Barclaycard (Currently selling in US for over US$500!)

(Prices exclude VAT please add at 17·5%) (Delivery 7 days, **£5.00** for UK)

**INTERCONNECTIONS LTD**
Unit 51, InShops, Wellington Centre, Aldershot, Hants, GU11 5DB
Tel: (01252) 341900 Fax: (01293) 822786

# “Your low cost route to embedded 8051”



## MICRO-PRO 51

*“Hardware/software upgradeable programmer for the 8051 family”*

- *Accepts up to 40 pin DIL directly via Aries ZIF socket*
- *Surface mount and PLCC package adaptors available as optional extras*
- *Atmel 8951/8952 & 1051/2051 ICE cables available as optional extras*
- *Field programmable hardware to allow future upgradeability*
- *Fast PC parallel port based design*

**ONLY £125**

**Programming support for the following devices:**
Generic 8751/8752 microcontrollers from Intel & Philips
Atmel 8951/8952 FLASH replacements for the 8751/8752
Atmel 1051/2051 20-pin FLASH 8051 microcontroller derivatives
Serial EEPROMS families: 24Cxx, 93Cxx, 59Cxx, **25Cxx**

## KEIL C51 PK LITE

*“The complete Ansi-C development environment for the 8051”*

- *Optimising Ansi-C compiler*
- *dscpoe-51-8051 software simulator & source level debugger*
- *uVision-Integrated Windows based C51 project management system*
- *Support for most 8051 derivatives eg. Atmel, Intel, Siemens etc.*
- *Numerous microcontroller language extensions for the fastest, tightest code*

**ONLY £110**

**(Restricted to 2K total program code, SMALL model only)**

KEIL™ SOFTWARE

## Embedded C51 Starter Systems for the 8051 family

*“Everything you require to develop an embedded 8051-based project in C”*

- *MICRO-PRO 51 device programmer*
- *KEIL C51 PK LITE*
- *Sample Atmel FLASH microcontrollers*
- *Full suite of C51 demonstration software*

**Atmel 8051 FLASH Microcontroller Range**

| | 8951 | 8952 | 1051 | 2051 |
|---|---|---|---|---|
| FLASH code ROM | 4K | 8K | 1K | 2K |
| RAM | 128 | 256 | 64 | 128 |
| I/O | 32 | 32 | 15 | 15 |
| Timer/Counter (16 bit) | 2 | 3 | 1 | 2 |
| Serial Port | YES | YES | NO | YES |
| Interrupt Sources | 5 | 8 | 3 | 5 |
| Pins (DIL/PLCC) | 40/44 | 40/44 | 20 | 20 |
| Special features | | Timer 2 | Comparator | Comparator |

**895X-ST (ONLY £215)**
**Comes complete with samples of Atmel 8951 and 8952 40 pin microcontrollers**
**XO51-ST (ONLY £199)**
**Comes complete with samples of Atmel 1051 and 2051 20 pin microcontrollers**

EQUINOX TECHNOLOGIES

*Equinox Technologies, 229 Greenmount Lane Bolton BL1 5JB. Lancashire. ENGL AND*
*Tel: (01204) 492010 Fax: (01204) 494883 Int. dialling code (UK +44 1204)*
*E-mail: sales@equintec.demon.co.uk Web Page: www.demon.co.uk/equintec*
*All prices exclusive of VAT and carriage.*

# PIC 16C84 PROGRAMMER

## LEARN THE SECRETS OF PROGRAMMING THIS VERSATILE RE-WRITABLE MICRO CONTROLLER.

PROGRAM

READ

VERIFY

EDIT PROGRAM

EDIT DATA

SAVE DATA / PROG

ONLY £49 INCLUSIVE !!!

NEW

SAVE YOURSELF HOURS OF WIRING LOGIC CHIPS
JUST PROGRAM A PIC 16C84 INSTEAD.
VERY EASY TO LEARN
IDEAL FOR ALL TYPES OF APPLICATIONS

PIC16C84 £6 EACH

SIMPLY CONNECTS TO YOUR COMPUTER PRINTER PORT VIA PRINTER LEAD. COMPLETE WITH SOFTWARE ON 3.5"DISK & EASY TO FOLLOW INSTRUCTIONS & PROGRAMMING DATA.

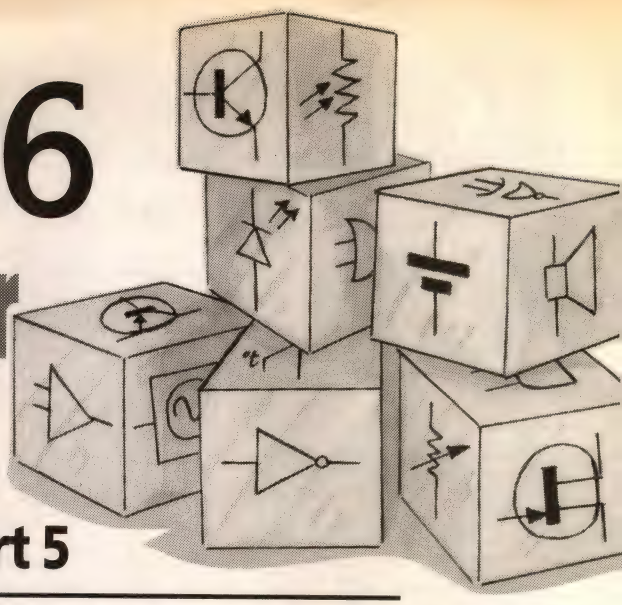
**LOW COST COMPONENT PACKS** *WHILE STOCKS LAST !!*

7805 REG PK OF 4 £1
7812 REG PK OF 4 £1
TIP31A PK OF 5 £1
TIP31A PK OF 5 £1
RED 3mm LED PK OF 15 £1
GRN 3mm LED PK OF 15 £1
YEL 3mm LED PK OF 15 £1
ZTX 300 TRAN PK OF 15 £1
Z80 CPU 4MHZ PK OF 2 £1
100uF 25v Min Rad PK OF 15 £1
680uF 35V Min Rad PK OF 10 £1
22PF CERAMIC CAP PK OF 20 £1
4.00 MHz Xtal PACK OF 4 £1
32.768 Hz Xtal PACK OF 5 £1
74HCT04 PK OF 10 £1
74HCT138 PK OF 5 £1
74HCT245 PK OF 4 £1
74HCT374 PK OF 5 £1
PIC16C84 PK OF 3 £15

**TELE-SALES 01530-413141**
**SKYMASTERS,DEPT EPE, 10 THE GREEN, ASHBY DE LA ZOUCH, LEICS LE65 1JU**
**TRADE / EXPORT WELCOME - FAX No 01530-412151**
**ALL PRICES INC VAT - PLEASE ADD £1 P/P FOR COMPONENT PACKS - SAE FOR CATALOG.**

# TEACH-IN '96

# A Guide to Modular Circuit Design



**Max Horsey**

## Part 5

DURING this series of articles, a range of circuit modules is examined, divided into Input, Processor and Output sections. Where possible a choice of module is offered within each section.

Each of the ten Parts of the Series is accompanied by a constructional article explaining how a complete project may be devised by employing the modules described, together with a p.c.b. design. Each project will be one of many possible ideas that could be implemented and it is hoped that readers will design for themselves a variety of circuits by combining modules provided in the whole series.

The proposed range of modules covered by the Series is detailed in Part 1, Table 1.1. Each module is chosen to link easily with adjacent modules in the same Part, but modules may also be linked with modules in other Parts of the Series.

Max Horsey is Head of Electronics at Radley College.

THIS fifth Part of the *Teach-In* series continues with a look at more Input, Processor and Output modules, with a particular view towards an infra-red (IR) control system suitable for driving any output circuit in the series.

The following modules are discussed:

**INPUT MODULE:** IR receiver and preamplifier

**PROCESSOR MODULES:** Encoder/decoder, D-type bistable, T-type bistable, J-K bistable

**OUTPUT MODULE:** IR transmitter with high power pulsed Darlington output

One way in which the modules can be connected together to form an on/off remote control system is described in the accompanying project elsewhere in these pages, the *Infra-Zapper* – a device to test your "targeting" skill!

(Another use of similar modules is illustrated in the author's *Infra-Red Remote Control Unit* which controls his *Automatic Curtain Winder* project. These were published in *EPE* August and July '95 issues, respectively. The August '95 IR unit uses the same remote control encoder/decoder described here, together with T-type bistables.)

## POWER SUPPLY

Some of the integrated circuits (i.c.s) in this part have rather awkward power supply requirements! The encoder/decoder i.c. (UM3750) can operate on 3V up to a maximum of 11V. The CMOS i.c.s used as bistables will work on 3V to 15V. However, the IR preamplifier i.c. (TBA2800) has a maximum working voltage of 5·5V. Consequently, to suit this i.c., *a 5V (or 4·5V) supply must be used with all the modules in this Part.*

## IR RECEIVER AND AMPLIFIER

Several devices capable of responding to an infra-red signal are available, although discussing alternatives is beyond the scope of this article. Many electronic components catalogues, though, contain a range of substitutes and should be consulted if alternatives to the suggested combination of the IR photodiode sensor TIL100 and preamplifier TBA2800 are required.

Output signals available from IR photodiodes are very small, and may contain unwanted interference from other sources, such as lamps and daylight etc. The preamplifier must be carefully designed to reject this interference, yet still provide a large amount of signal gain.

The TBA2800 is specifically designed for infra-red work and achieves these requirements by means of three stages of amplification and includes automatic gain control. It is a complex device in a small, low-cost package.

The full circuit diagram of the IR Input Module is shown in Fig. 5.1. At first glance, the circuit appears complicated, but in fact

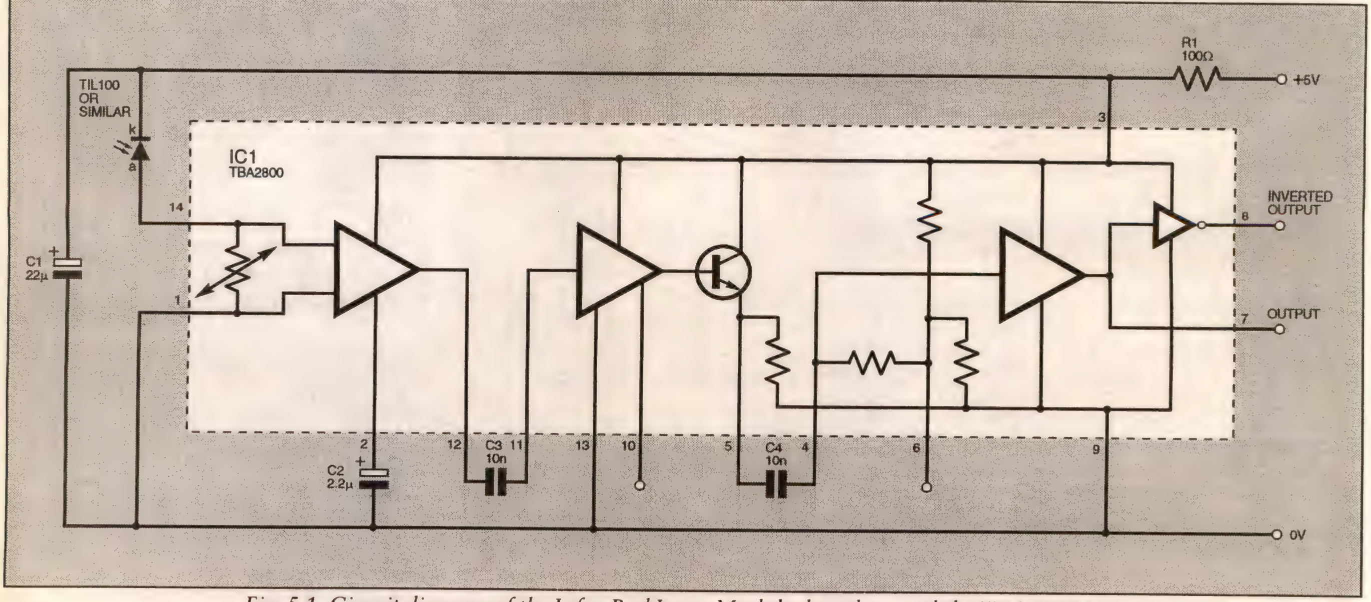


*Fig. 5.1. Circuit diagram of the Infra-Red Input Module, based around the TBA 2800 i.c.*

there are only six components needed in addition to the i.c., whose manufacturer has done the rest! The dotted box indicates the internal circuitry of the TBA2800 in block diagram form. The pin numbers of the i.c. are shown around the dotted box.

Two outputs are provided, a "normal" output from pin 7 and an inverted output from pin 8. The values of the capacitors have been chosen in relation to the signal being processed, as discussed later. Some experimentation may be necessary if other signals are required.

Resistor R1 provides a degree of isolation for the i.c. The effect of R1 together with capacitor C1 is to provide a very smooth electrical supply for the circuit, even if the voltage fluctuates elsewhere. All the spare connections should be left unconnected. Note that when connecting this module to the decoder described later, the inverting output (pin 8) should be used.

## TESTING THE CIRCUIT

In the author's experience, testing infra-red control circuits is one of the more frustrating areas of electronics, but the following may be helpful, providing an oscilloscope is available. (In the absence of an oscilloscope, testing is best left until the IR Transmitter has been constructed.)

1. Borrow an infra-red remote control unit from a TV or video recorder
2. Connect the oscilloscope ground to 0V in the circuit
3. Connect the oscilloscope probe to the leg of the IR photodiode which is connected to pin 14 of the i.c.
4. Aim the remote control unit at the flat side of the photodiode and press any key – a signal should appear on the oscilloscope screen
5. If not, check that the IR photodiode is connected the correct way round (see Fig. 1.14 in Part 1)
6. An amplified signal should be present on pins 12 and 5 of the i.c.
7. Finally, a much amplified signal should be present at the output pin 7, and an inverted version at output pin 8.

## ENCODING AND DECODING

The TBA2800 IR receiver/amplifier provides an output signal when any IR transmission is detected. However, most people have at least one, and in many cases several, remote control units. Encoding/decoding is necessary in order to differentiate between them. This has the additional advantage that a circuit can be programmed to "look" for a particular signal even though it may be much weaker than other IR sources, such as daylight.

Several dedicated encoders and decoders are available for IR control systems. Here an i.c. has been chosen which does both jobs, the UM3750.

The UM3750 encoding/decoding i.c. can be used with many types of control system, including infra-red, visible light, radio or ultrasonic. It is designed to send a particular code depending upon which of 12 input pins are connected to 0V or left open circuit. This provides a total of 4096 possible combinations.

A second UM3750 i.c. can be set to the same combination and will only provide an output when it receives precisely the same code.

Note that the system is designed for a single transmitted signal. For example, to open a garage door or close a pair of curtains. It could be adapted for a multi-channel system, such as the type used to control a video recorder, but other specialised i.c.s are available for this purpose.

Whatever type of transmission control system the pair of circuits might be used with, it is important to ensure that the exact shape of the coded signal remains intact.

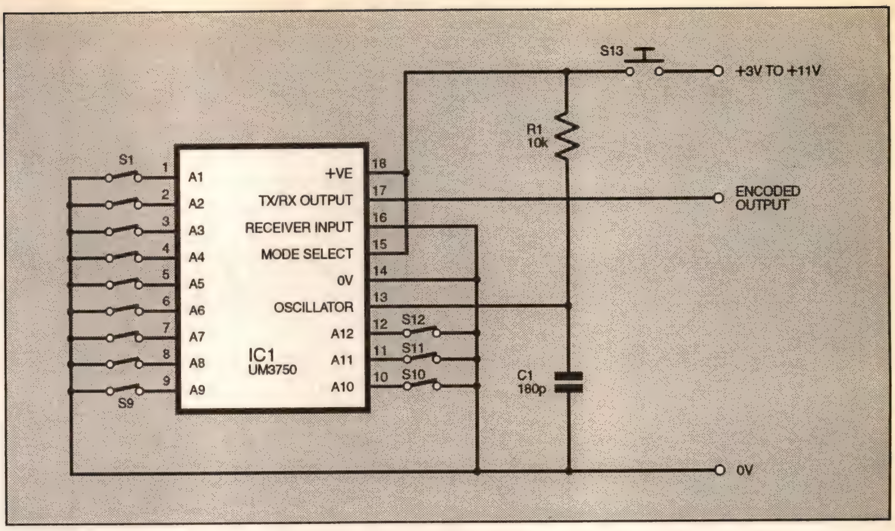


Fig. 5.2. Circuit diagram for the encoder module.

## ENCODING CIRCUIT

One method by which encoding can be accomplished is shown in Fig. 5.2

Switches S1 to S12 can be toggle switches, p.c.b. mounting d.i.l. (dual-in-line) switches, or simply wire links, inserted or not inserted to make up a particular code. Switch S13 must be pressed to transmit the encoded signal.

When experimenting, all i.c. pins 1 to 12 can be left open circuit (i.e. not connected). The only reason for connecting some to 0V is to ensure that another remote control unit (with the same circuit) will not operate your device accidentally.

The combination of resistor R1 and capacitor C1 sets the frequency of the coded signal. Depending upon the control and transmission system used, R1 and/or C1 may need to be changed in value. It is essential to make identical changes in the decoder circuit.

## DECODER

The decoder circuit is very similar to the encoder, and is shown in Fig. 5.3.

For testing purposes, the encoded output (Fig. 5.2) can be connected to the encoded input (Fig. 5.3). The output from Fig. 5.3 is normally high (positive). When the correct code is received, it goes low for a short time (about 0·1s). In fact, the i.c. waits until it has received four valid codes in quick succession to ensure against false triggering.

The output is capable of sinking 2mA when low (active). Although this *could* be used via a transistor circuit to operate an l.e.d., the short time for which the output is pulsed low suggests the need for a monostable to extend the pulse length (described in Part 2, Fig. 2.8 and Fig. 2.9), or a simple latching circuit (Part 3, Fig. 3.8, Fig. 3.10 and Fig. 3.11).

A monostable allows a short input pulse to trigger an output pulse of any preset duration required. A latching circuit enables a short input pulse to be used to indefinitely switch on an output device.

Obviously, in a practical situation, the latch must have a means of being unlatched (reset) when required and some more complex latches or bistables are described shortly. These latch when the first pulse is received, then unlatch at the second pulse, etc.

## BISTABLES (FLIP-FLOPS)

In Part 3, a bistable made from a pair of NOR gates was examined (Fig. 3.11) and its use as a latch discussed. A bistable (which is also commonly known as a *flip-flop*) is a circuit configuration which has

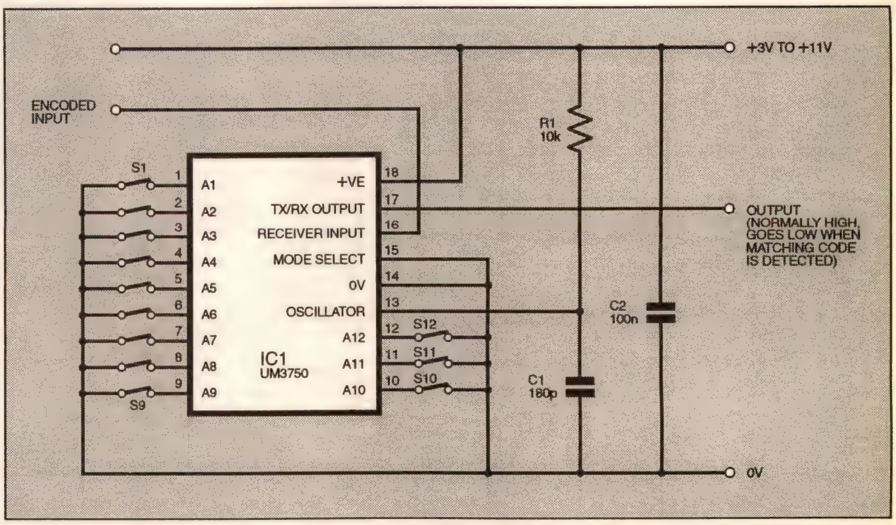


Fig. 5.3. Circuit diagram for the decoder module.

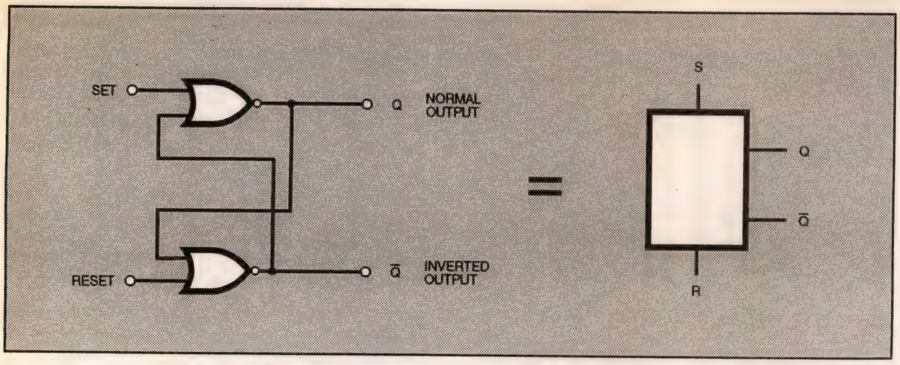


*Fig. 5.4. Simple representation of a bistable (flip-flop).*

two stable states. One circuit representation of the concept is shown in Fig. 5.4

Assume that in an initial situation, inputs Set and Reset are held low. When Set is made high (positive) for a moment, output Q latches high, and $\overline{Q}$ (pronounced *NOT* Q) latches low. When Reset is made high for a moment, output Q latches low, and $\overline{Q}$ high.

The D-type bistable (D for Data) uses two extra connections, the Clock and Data inputs, as shown in Fig. 5.5.

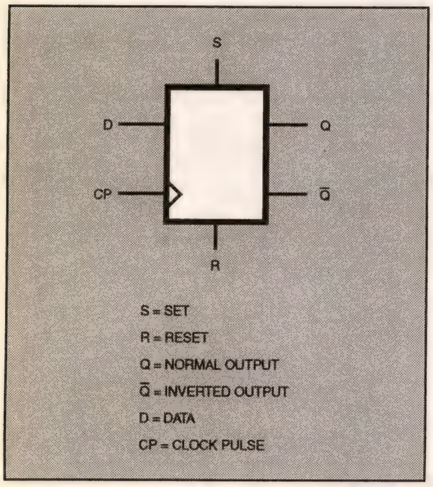


*Fig. 5.5. D-type bistable symbol.*

The pin labelled *D* is the Data input. The pin labelled *CP* (or *CK*) is the Clock input. The state of the Data input is ignored by the bistable unless the Clock input is switched from low to high.

To help understand this, only output Q will be considered, since $\overline{Q}$ will always be the opposite.

First, assume that output Q is low (0V) and that the Clock input CP is also low.

If the Data input is switched up or down between 0V and positive, the outputs will not change their logic state. If the Data input is held high, and at the same time the Clock input is switched from low to high, Q will copy the Data input, i.e. go high. The change occurs *at the instant* when the Clock input switches from low to high.

If the Data input is switched back to low, the outputs will not change their logic state, even though the Clock input is still high. If the Clock input is now switched low again, the outputs will still not change. However, if the Clock input is switched to high again, Q will copy the data input and go low.

To sum up, Q always copies the state of the Data input at the moment when the Clock input is changed from low to high. This operation is known as *edge-triggering*.

The Set and Reset inputs can still be used as before and control the bistable independently of the Data and Clock inputs.

## PRACTICAL NOTE

When using a D-type bistable, such as the CMOS 4013B, note that the positive supply is connected to pin 14, and the 0V supply to pin 7. All inputs must be connected in some way, i.e. not left open circuit. Spare unused inputs can be connected directly to either power line, 0V or +VE, as most convenient.

For example, the CMOS i.c. type 4013B contains a pair of D-type bistables. If only one of them is needed, then all the inputs of the other bistable can be connected to 0V. *Spare outputs should be left unconnected.*

## ADDING SWITCHES

The circuit shown in Fig. 5.6 indicates how the D-type bistable may be tested using push-to-make switches. Note the use of tie-down resistors which hold the inputs at 0V unless a switch is pressed, at which time they are forced positive. This type of switching and biasing arrangement has been shown in earlier parts of the Series.

In practice, designers would rarely wish to connect the Clock and Data input in this way, but it is a useful technique for controlling the Set and Reset inputs, and an ideal way of experimenting.

A voltmeter may be used to monitor the state of, say, output Q. Alternatively, an l.e.d. with a series resistor of about 330Ω may be connected between the output and 0V. The l.e.d. will tend to pull down the logic level at the output. This will not cause damage, but do not expect the output to also drive another input at the same time. (The series resistance required with l.e.d.s is discussed at the end of Part 4.)

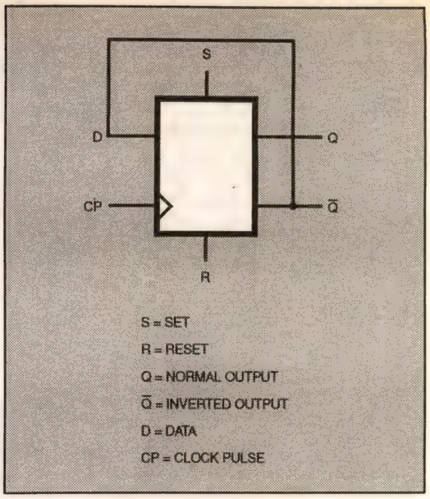


*Fig. 5.7. Using a D-type bistable as a T-type.*

The applications of the D-type bistable may not be obvious, but it forms the heart of virtually all counting and computing circuits and, above all, is easily made into a T-type bistable – a very useful device!

## T-TYPE BISTABLE

The T-type (T for Toggle) bistable produces the same action as a push on/push off switch, the type fitted to many TVs, etc. The first push latches the switch, the second push unlatches it. The T-type bistable does this electronically and can easily be made from a D-type bistable, as shown in Fig. 5.7.

Notice that the inverted output $\overline{Q}$ is connected to the Data input. This simple connection makes output Q change state every time the Clock input is switched from 0V to positive. This is how it works:

Begin by assuming that output Q is low, and therefore output $\overline{Q}$ is high.

Imagine that the Clock input is switched from low to high. Since the Data input is high (remember $\overline{Q}$ is high), this will be copied to Q, making Q high and $\overline{Q}$ low. Even though the Clock input may remain high, the outputs will be stable in this new state since data is only copied to Q at the moment when the Clock input changes from low to high.

Output $\overline{Q}$ will now be low, making the Data input low. If the Clock input is made low, nothing happens. However, when the Clock input becomes high again, the Data input is copied to Q making Q low, and therefore $\overline{Q}$ high.

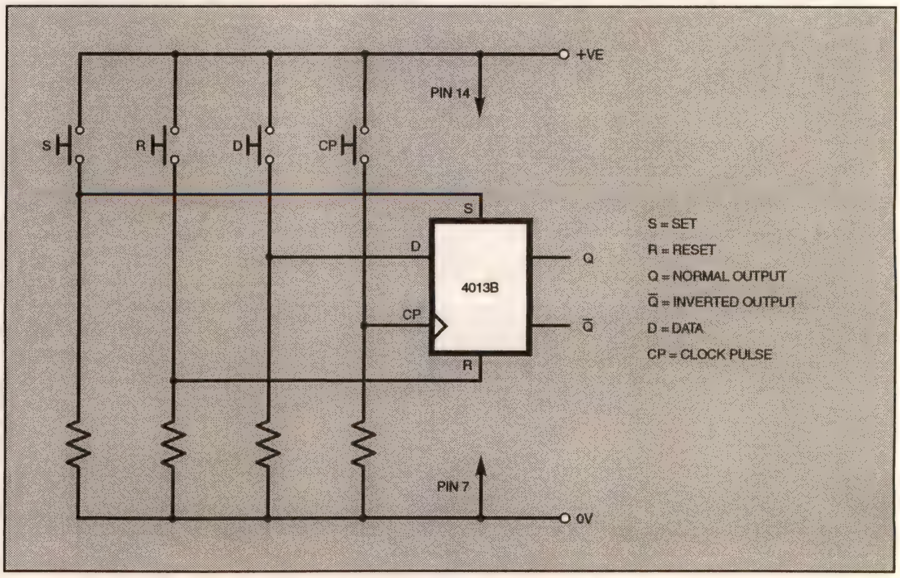


*Fig. 5.6. Circuit diagram showing how a D-type bistable can be tested.*

To sum up the operation of the T-type bistable:

First clock pulse causes Q to switch to high
Second clock pulse causes Q to switch to low
Third clock pulse causes Q to switch to high . . . etc.

Notice that Q switches between low and high at half the rate of the clock pulse. For this reason the circuit is sometimes called a frequency divider.

The two waveforms shown in Fig. 5.8 illustrate the relationship between the Clock input and the Q output. The clock pulse may or may not have an equal mark/space ratio, but the output from Q will *always* have an equal mark/space ratio when the clock pulse has a stable frequency.

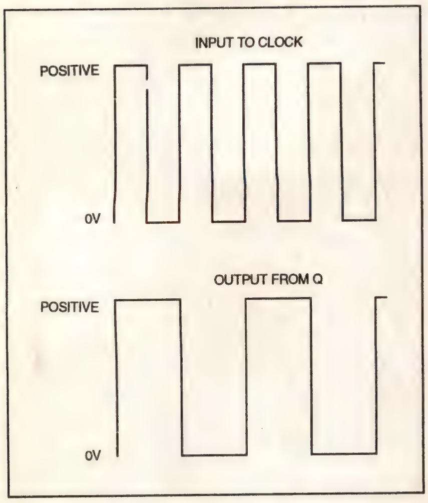


*Fig. 5.8. Waveforms illustrating relationship between T-type input and output.*

This toggle action is very useful. It could, for example, be used in conjunction with a simple remote control system, where the first press of the transmitter turns on a light, and the second press turns it off.

The modules can be cascaded (several modules connected one after the other) and used as a frequency divider, since each stage divides by two. The counting/timing projects in Parts 6 and 7 of this series use this principle. The way that T-type bistables can be cascaded is shown in Fig. 5.9. Used like this, they can form the heart of a binary counter.

Three T-type bistables are shown, although any number can be connected in the same way. Notice that the $\overline{Q}$ output from each module is connected both to the Data input of the same module and the Clock input of the next. If an l.e.d. is connected between each Q output and 0V (via a suitable resistor), the behaviour of the system can be observed. The Set and Reset functions can still be used as before.

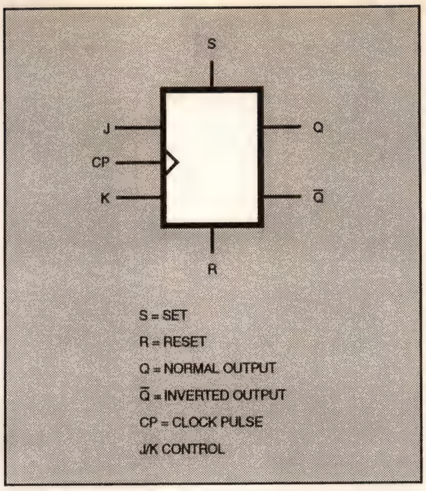


*Fig. 5.10. J-K bistable symbol.*

As discussed above, note that the inputs *must not* be left floating. Either connect them to 0V directly, or via resistors as shown in Fig. 5.6 if switches are required for setting or resetting.

## J-K BISTABLE

A J-K bistable is an even more flexible bistable, and is arranged as shown in Fig. 5.10.

The Set and Reset inputs work in the same way as with the D-type bistable, in other words they are independent and override the J, K and Clock inputs.

The J and K inputs also control the state of the outputs, but only at the moment when the Clock input changes from low to high (0V to positive):

| INPUT | INPUT | OUTPUT |
|---|---|---|
| J | K | Q |
| Low | Low | no change |
| High | Low | switches to high |
| Low | High | switches to low |
| High | High | changes state at each clock pulse |

In other words the bistable behaves as a T-type if both J and K are held at logic 1 (i.e. positive).

The J-K bistable provides greater flexibility than the standard D-type, but it may be a few pence more expensive, and has more pins.

A typical i.c. example of a dual J-K bistable is the CMOS 4027B, which is housed in a 16-pin d.i.l. package.

## LOGIC CONTROL

It is sometimes necessary to perform a sequence of events which move step by step with a clock pulse. Take, for example, the circuit in Fig. 5.11. This uses two D-type bistables and two NOR gates to control a sequence of three events, Open, Close and Stop.

The sequence can be controlled by a signal connected to the Clock input. The signal could be derived from another circuit, or a pushbutton switch could be used to create a single clock pulse whenever it is pressed.

At the start of the cycle, Stop is high, and Open and Close are low. When the switch is pressed, Stop goes low and Open goes high. At the next switch press, Open goes low and Stop goes high. At the next press, Stop goes low and Close goes high. The next press of the switch returns the module to its starting point.

To sum up, the sequence controlled by the circuit in Fig. 5.11 is:

Stop – Open – Stop – Close – Stop

This repeatable sequence is very useful for remote controlling mechanisms such as garage doors or curtains, etc.

To understand the working of the circuit, first recall the logic of a NOR gate truth table, in which High = 1 and Low = 0, as follows:

| INPUT A | INPUT B | OUTPUT |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

Relating this table to IC2a, pin 8 is Input A, pin 9 is Input B and pin 10 is the output. With IC2b, the equivalent pins are 12, 13 and 11, respectively.

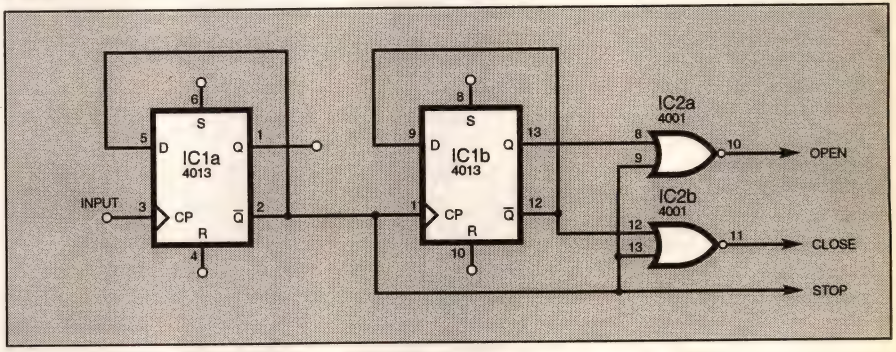


*Fig. 5.11. Circuit for controlling a 3-event sequence.*

In Fig. 5.11, clock pulses are fed to IC1a pin 3. Output pin 1 (Q) is not connected but is shown for reference. Output pin 2 ($\overline{Q}$) is used as the clock source for the next bistable and provides the input logic level to Inputs B of both NOR gates IC2a and IC2b. Thus:

Output at IC2a pin 10 =
IC1a pin 2 NORed with IC1b pin 13

Output at IC2b pin 11 =
IC1a pin 2 NORed with IC1b pin 12

The logical sequence is shown in Table 5.1.

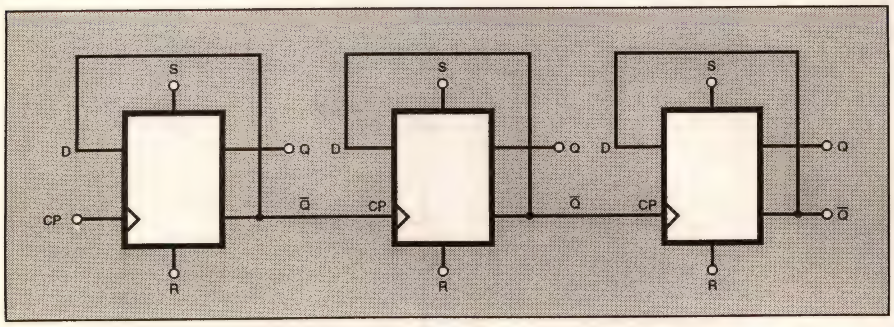


*Fig. 5.9. Cascading T-type bistables.*

**Table 5.1. Logic table for Fig. 5.11.**

| CONDITION | IC1 | IC1 | IC1 | IC1 | IC2 | IC2 | STATUS |
|---|---|---|---|---|---|---|---|
| | Pin 1 | Pin 2 | Pin 13 | Pin 12 | Pin 10 | Pin 11 | |
| Fully reset | 0 | 1 | 0 | 1 | 0 | 0 | Stop |
| 1st pulse | 1 | 0 | 0 | 1 | 1 | 0 | Open |
| 2nd pulse | 0 | 1 | 1 | 0 | 0 | 0 | Stop |
| 3rd pulse | 1 | 0 | 1 | 0 | 0 | 1 | Close |
| 4th pulse | 0 | 1 | 0 | 1 | 0 | 0 | Stop |

# OUTPUT MODULE

The output module about to be described shows how an encoder may be linked to a Darlington transistor pair to make a remote control transmitter.

The method by which a signal can be encoded was shown in Fig. 5.2. What is now required is a way of boosting the output to a current capable of driving three infra-red l.e.d.s to full capacity.

In Part 1, a Darlington pair configuration which is capable of considerably boosting a small current was described (Fig. 1.13b). The Darlington principle is used at the heart of the output transmitter circuit shown in Fig. 5.12.

Within the dotted box, designated TR1, two transistors are shown representing the Darlington pair. In practice, this configuration may be either a single *npn* Darlington transistor, such as a TIP121 or TIP122, or may be comprised of two separate *npn* transistors, such as a BC184L (or similar) followed by a power transistor, such as a TIP41A.

The parallel value of resistors R2 to R4 (3·3 ohms) appears to allow a total of over 2A to flow. Clearly, neither the l.e.d.s nor a conveniently-sized battery would be able to tolerate this current, so the circuit contains an additional 100 ohm resistor, R5, which limits the total current to less than 100mA.

This extra resistance would reduce the possible transmission range and so the current is used to charge electrolytic capacitor C1. When switch S1 is pressed, a large current flows from the capacitor through the l.e.d.s for a short time. The pulse is too short to cause any damage, but provides the punch necessary to increase the range of the remote control system to several metres.

Of course, as discussed in Part 1, the transistors will not turn on without at least 1·4V applied to the Darlington base (b) via resistor R1. This voltage would normally be supplied in the form of a pulsed signal and in this case the module can be driven from the output of the encoder module described earlier.

Diode D4 prevents disaster to the circuit if the supply is accidentally reversed. Such action will cause the battery to short circuit through the diode and resistor. This is preferable to destroying the IR l.e.d.s and capacitor etc. A series diode could be used instead of the parallel diode shown, but its forward voltage drop may be unacceptable when every ounce of power is needed.

When setting up the infra-red l.e.d.s, try to point them in slightly different directions, so that the remote control unit is not too directional. If you are happy to point the unit *carefully* at the receiver, one or two infra-red l.e.d.(s) might be sufficient. It is also worth experimenting with high power IR l.e.d.s if available.

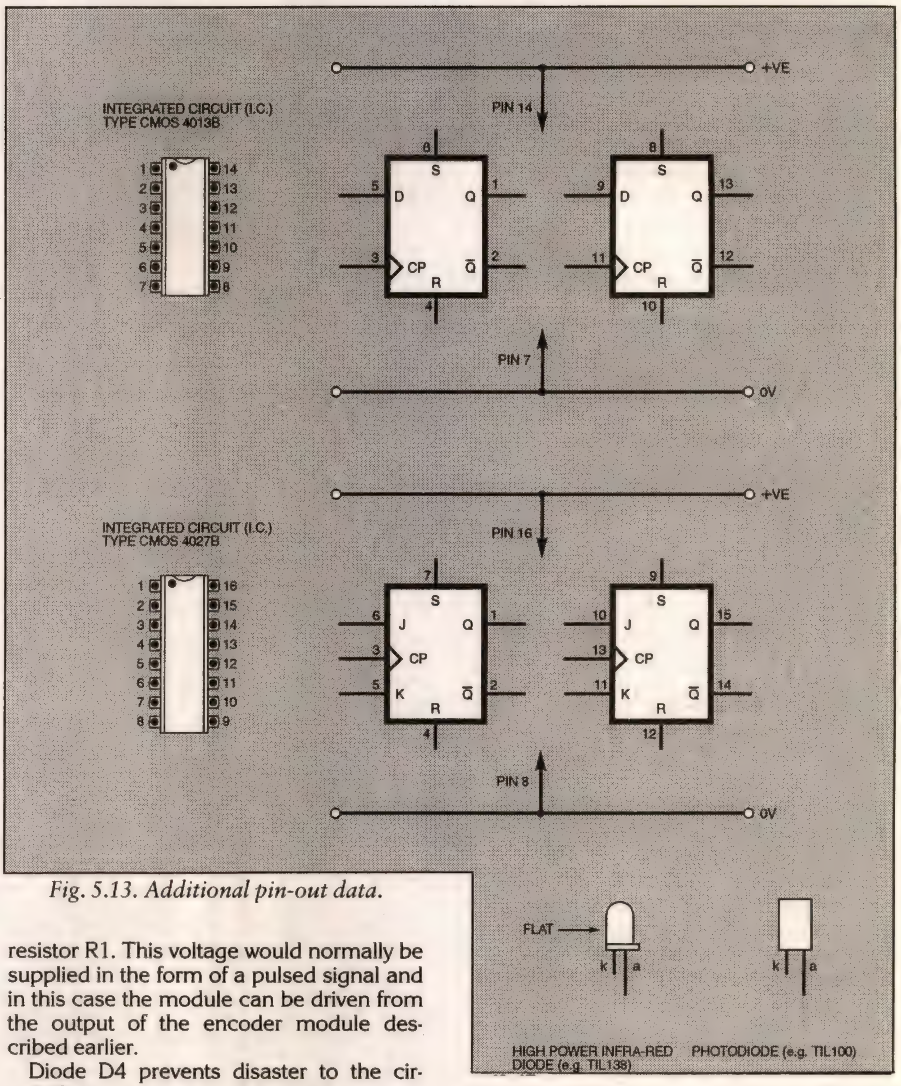

INTEGRATED CIRCUIT (I.C.) TYPE CMOS 4013B
+VE
PIN 14
S
D
Q
CP
R
Q̄
PIN 7
0V
INTEGRATED CIRCUIT (I.C.) TYPE CMOS 4027B
+VE
PIN 16
J
K
PIN 8
0V
FLAT
k
a
HIGH POWER INFRA-RED DIODE (e.g. TIL138)
PHOTODIODE (e.g. TIL100)

*Fig. 5.13. Additional pin-out data.*

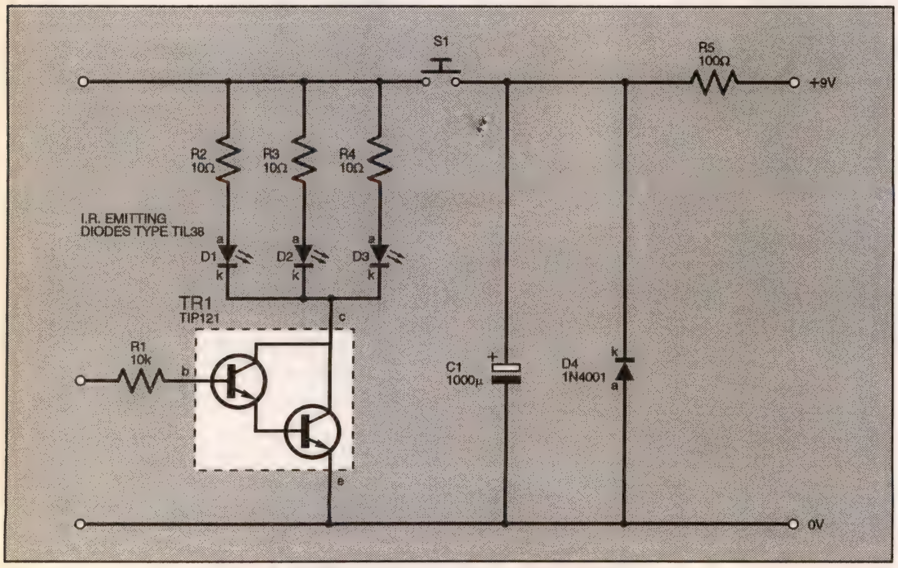


*Fig. 5.12. Output transmitter circuit diagram.*

# PINOUT DATA

Pinout data for the semiconductors used in the *Teach-In* series so far is given in Part 1, Fig. 1.14, except for the CMOS 4013 and 4027 bistables, and the TIL138 and TIL100 diodes, whose pinouts are shown in Fig. 5.13.

# PART SIX

The modules to be examined in *Teach-In* Part 6 are: switch debouncer, R/C monostable, more counters and a liquid crystal decoder/driver. The example project is an Event Counter.

## EXAMPLE PROJECT

The Infra-Zapper unit is the example project (elsewhere in these pages) which shows how the modules in *Teach-In* Part 5 can be combined in a practical application.

EVERYDAY
PRACTICAL
ELECTRONICS

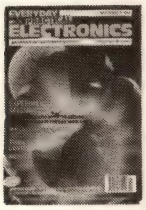
# BACK ISSUES

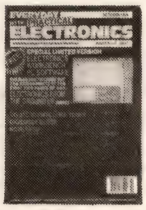
We can supply back issues of *EPE* by post, many issues from the past five years are available. An index for each year is also available – see order form. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photostat of any *one article* (or *one part* of a series) can be purchased for the same price.

## DID YOU MISS THESE?

### SEPT. '94

**PROJECTS** • Protector Plus Car Alarm • Greenhouse Watering System • Experimental Seismograph, Part 1 • Three-Channel Lamp Controller • Dancing Fountains, Part 2.
**FEATURES** • Calculation Corner, Part 9 • The Invisible Force (magnetic force).





### OCT. '94

**PROJECTS** • Digilogue Clock • Visual/Audio Guitar Tuner • Hobby Power Supply • Audio Auxiplexer • Experimental Seismograph, Part 2.
**FEATURES** • Electronics from the Ground Up, Part 1 with **FREE** PC Software • Calculation Corner, Part 10.

### NOV. '94 Photostats Only (see below)

**PROJECTS** • 1000V/500V Insulation Tester • Video Modules, Part 1 (Simple Fader, Improved Fader, Video Enhancer) • Active Guitar Tone Control • Power Controller • TV Off-er.
**FEATURES** • Electronics from the Ground Up, Part 2 • Consumer Electronics Show.

### DEC. '94

**PROJECTS** • Spacewriter Wand • *EPE* Fruit Machine • Universal Digital Code Lock • Video Modules, Part 2 (Horizontal Wiper, Vertical Wiper, Audio Mixer) • Rodent Repeller.
**FEATURES** • Electronics from the Ground Up, Part 3 • Embedded Controllers • Index for Volume 23.

### JAN. '95 Photostats Only (see below)

**PROJECTS** • Magnetic Field Detector • Moving Display Metronome • Model Railway Track Cleaner • Beating the Christmas Lights • EPE Fruit Machine, Part 2 • Video Modules, Part 3 (Dynamic Noise Limiter, System Mains Power Supply).
**FEATURES** • Electronics from the Ground Up, Part 4 • Electromagnetic Compatibility • Checking Transistors.

### FEB. '95

**PROJECTS** • 12V 35W PA Amplifier • Foot-Operated Drill Controller • The Ultimate Screen Saver • MIDI Pedal Board • Model Railway Signals.
**FEATURES** • Electronics from the Ground Up, Part 5 • Transformerless Power Supplies • Quickroute 3.0 Review.

### MARCH '95

**PROJECTS** • Multi-Purpose Thermostat • Name of the Game-1 Counterspell • Sound Activated Switch • Audio Amplifier • Light Beam Communicator.
**FEATURES** • Electronics from the Ground Up, Part 6 • Understanding PIC Microcontrollers • Visio Graphics Software Review.
**FREE** Multi-Project PCB with this issue.

### APRIL '95

**PROJECTS** • National Lottery Predictor • Auto-Battery Charger • Light-Activated Switch • Switch On/Off Timer • Continuity Tester • Name of the Game-2 Counterspin.
**FEATURES** • Electronics from the Ground Up, Part 7 • Circuit Surgery • The Hard Cell (Mobile Telephones).

### MAY '95

**PROJECTS** • PIC-DATS-1 (PIC Development and Training System) • R.F. Signal Generator – 1 • MIDI Pedal • Club Vote Totaliser • Name of the Game-3, On Your Marks and Games Timer.
**FEATURES** • Electronics from the Ground Up, Part 8 • Las Vegas Show Report.

### JUNE '95 Photostats Only (see below)

**PROJECTS** • PIC-DATS-2 (PIC controlled 4-Channel Light Chaser) • EPE HiFi Valve Amplifier – 1 • R.F. Signal Generator – 2 • AA to PP3 Converter • Name of the Game – 4, Star-Struck!, Six-Shot Light Zapper, Wander Wands.
**FEATURES** • Electronics from the Ground Up, Part 9 • Smart Cards.

### JULY '95

**PROJECTS** • Windicator • Curtain Winder • Ramp Generator – 1 • High Voltage Capacitor Reformer • EPE HiFi Valve Amplifier – 2
**FEATURES** • Bridge Rectification Enhanced • Ingenuity Unlimited.

### AUG '95

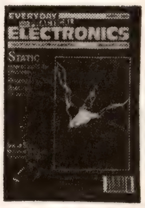
**PROJECTS** • Solar Seeker • Personal Practice Amplifier • Infra-Red Remote Control Unit • Versatile Microcontrolled 3-Digit Timer • Ramp Generator – 2.
**FEATURES** • Static • Circuit Surgery.

### SEPT '95 Photostats Only (see below)

**PROJECTS** • Simple Theremin • Low Range Ohmmeter Adaptor • Comprehensive Security System • Vandata • Hum-Free Battery Eliminator.
**FEATURES** • Cave Radio • Ingenuity Unlimited.

### OCT '95

**PROJECTS** • Ginormous VU Meter • Sound Switch • Audio Sinewave Generator • Treble Booster • Infra-Red Controller/Alarm • Capacitor Check • Experimenter's Bargraph Test Board.
**FEATURES** • Circuit Surgery • Security Tagging • Using Bargraph Displays.
**FREE** • Multi-Project PCB with this issue.



### NOV '95

**PROJECTS** • Digital Delay Line • Video Enhancer • 50Hz Field Meter • Temperature Warning Alarm • Current Tracer • Distortion Effects Unit.
**FEATURES** • Teach-In '96 Part 1 • Developments in Radio Broadcasting Technology • Turnpike for Windows Review • Ingenuity Unlimited.

### DEC '95

**PROJECTS** • Light Operated Switch • Stereo "Cordless" Headphones • EPE Met Office – 1 • Modular Alarm System • Audio Meter and Amplifier.
**FEATURES** • Teach-In '96 Part 2 • Circuit Surgery • Index for Volume 24.

### JAN '96

**PROJECTS** • Printer Sharer • Mains Signalling Unit • Automatic Camera Panning System • Audio Signal Generator • EPE Met Office – 2.
**FEATURES** • Teach-In '96 Part 3 • Ingenuity Unlimited • European Consumer Electronics Show • Techniques – Actually Doing It • Maths Plus Review • Decibels and dBm Scale.

### FEB '96

**PROJECTS** • Simple PIC16C84 Programmer • Mains Signalling Unit – 2 • PIC Electric Meter – 1 • Vari-Speed Dice • Analogue Frequency Meter.
**FEATURES** • Teach-In '96 Part 4 • Circuit Surgery • Making Your Own P.C.B.s • Techniques – Actually Doing It.

**BACK ISSUES ONLY £2.50 each inc. UK p&p.**
**Overseas prices £3.10 each surface mail, £4.10 each airmail.**

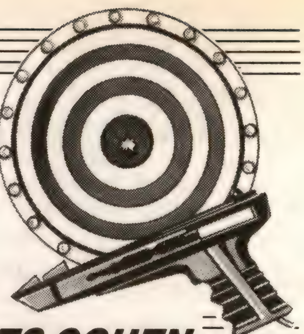
We can also supply issues from earlier years: 1989 (**except** March, June and Nov), 1990 (**except** March), 1991 (**except** May, June, Aug., Sept. and Nov.), 1992 (**except** April and Dec.), 1993 (**except** Jan., Feb. and March), 1994 (**except** April, June and Nov.), 1995 (**except** Jan., June and Sept.). Please note we are not able to supply copies (or 'stats of articles) of *Practical Electronics* prior to the merger of the two magazines in November 1992.
Where we do not have an issue a photostat of any *one article* or *one part* of a series can be provided at the same price.

**ORDER FORM** – BACK ISSUES – PHOTOSTATS – INDEXES

☐ Send back issues dated ..............................
☐ Send photostats of (article title and issue date) ..............................
☐ Send copies of last five years indexes (£2.50 for five inc. p&p – Overseas £3.10 surface, £4.10 airmail)
Name ..............................
Address ..............................
..............................
☐ I enclose cheque/P.O./bank draft to the value of £..............................
☐ Please charge my Visa/Mastercard £..............................
Card No. .............................. Card Expiry Date ..............................

**Note: Minimum order for credit cards £5.** Please supply name and address of cardholder if different from that shown above.
SEND TO: **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.**
Tel: 01202 881749. Fax: 01202 841692. (Due to the high cost we cannot reply to queries or orders by Fax.)
Payments must be in £ sterling – cheque or bank draft drawn on a UK bank.
Normally supplied within seven days of receipt of order.
*Send a copy of this form, or order by letter if you do not wish to cut your issue.*
M3/96

*Teach-In '96 – Constructional Project*



# INFRA-ZAPPER

## MAX HORSEY

## PCB DESIGN BY JAMES COHEN

*Improve your targeting aim and make light work of that flashy ring leader. Illustrates how Teach-In Part Five might be applied.*

BASED on the information provided in *Teach-In* Part 5, this article shows how modules may be selected and combined to produce a working project.

The Infra-Zapper is designed for target practice! An infra-red "gun" is aimed at a target consisting of a circular set of lights which appear to rotate. There is hole in the centre of the circle behind which is a target detector activate by an infra-red (IR) light beam. When the target is hit, a buzzer sounds for a short time, and the rotating lights pause.

The system uses the infra-red modules from *Teach-In* Part 5, plus a transistor driver from Part 1, a monostable from Part 2, and an Astable and Decade Counter from Part 4.

An output is also provided which will link with the *Event Counter* module to be described in *Teach-In* Part 6. Apart from being a fun project in its own right, the Infra-Zapper also proves that a variety of modules from different areas of the Series really will work together!

### TRANSMITTER BLOCK DIAGRAM

To begin with, take a look at the block diagram of the Transmitter, as shown in Fig. 1.

The Transmitter, which is constructed in the shape of a gun, has a pushswitch (the gun's trigger). When triggered, it switches on an encoder module, based on Part 5 Fig. 5.2.

The output from the encoder is amplified by means of a Darlington driver (as shown in Part 5 Fig. 5.12) before being delivered to a single infra-red transmitting l.e.d. Although the use of *several* l.e.d.s was described in Part 5, a single l.e.d. is suggested here in order to make the transmitter more directional; after all, the purpose is to test your ability to hit a target!

### TRANSMITTER CIRCUIT

The full circuit diagram of the Transmitter is shown in Fig. 2. The encoding circuit is based on IC1, the UM3750. Switches S1 to S12 set the code required. In practice, one or two wire links can be used instead of switches since the code is unlikely to have to be changed. If wire links are omitted, it is the equivalent of switching off a particular switch (unused inputs to IC1 do not need to be connected to the positive power rail).

Resistor R1 and capacitor C1 set the frequency of the encoded signal, and C2 removes any spikes on the supply rails. The output from the encoder i.c. is via IC1 pin 17 and is fed through limiting resistor R2 into the base (b) of Darlington driver transistor TR1. The amplified signal controls the high power infra-red l.e.d. D2. Resistor R3 limits the current through the l.e.d. in conjunction with R4.

When switch S13 is pressed, the charge on capacitor C4 is delivered to the circuit to provide a surge of energy for a short time. This makes it more difficult to cheat by holding the trigger and sweeping the gun across the target. Some experimentation with the values of R4 and C4 may be necessary for the best effect in a particular situation.

Diode D1, with help from capacitor C3, ensures that a reasonable supply voltage exists across IC1 even though the voltage across C4 collapses immediately S13 is pressed.

A monostable (from Part 2) could have been used to provide a carefully measured pulse from the gun. However, the design in Fig. 2 was chosen for its simplicity and hence compactness.

### RECEIVER BLOCK DIAGRAM

Referring to the Receiver block diagram in Fig. 3, the signal from the infra-red sensor is amplified in a circuit based on Part 5 Fig. 5.1. The signal is then decoded, before being used to trigger a monostable.

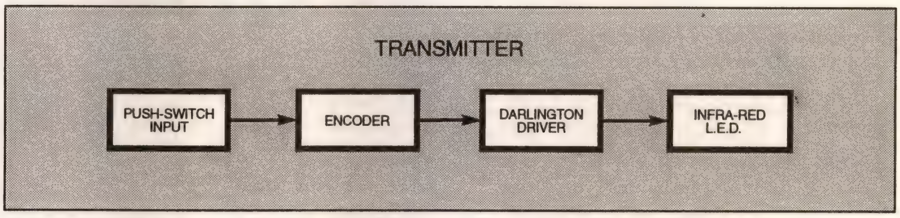
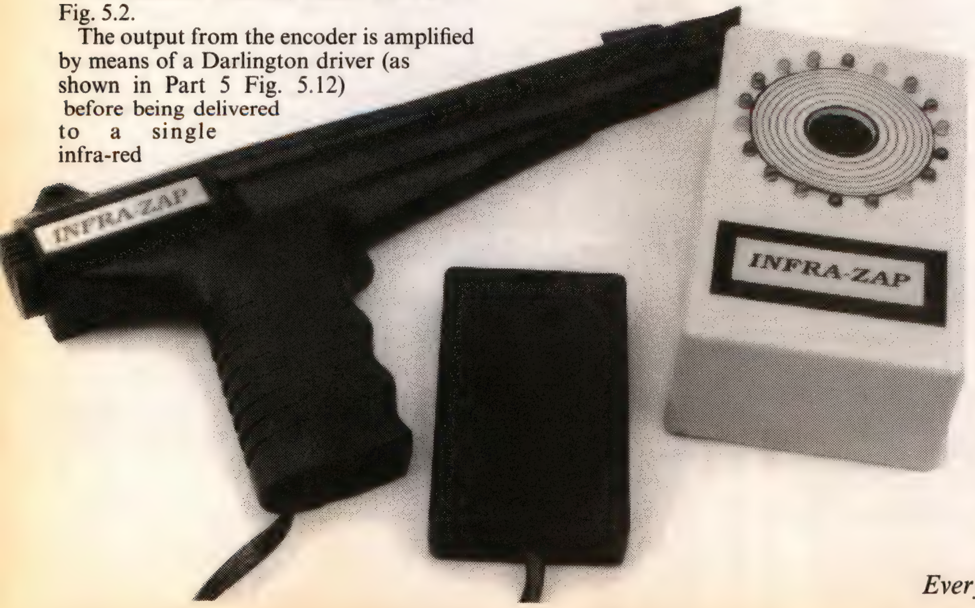


*Fig. 1. Block diagram for the Transmitter.*



The monostable in turn is used to trigger a buzzer to signal a successful "hit", and "jam" the astable which "freezes" the rotating l.e.d. display by inhibiting the astable. The astable normally oscillates when the monostable is untriggered and drives the chaser set of l.e.d.s.

### RECEIVER CIRCUIT

The full circuit diagram of the receiver is shown in Fig. 4. The infra-red receiver and amplifier is a direct copy of Part 5 Fig. 5.1. The inverted output from IC1 pin 8 is fed to IC2 pin 16. This i.c. decodes the signal according to the settings of switches S1 to S12. Again, in practice, wire links may be used instead of the switches. If a wire link is inserted, it represents a closed switch. A wire link not inserted represents an open switch, as described for the Transmitter.

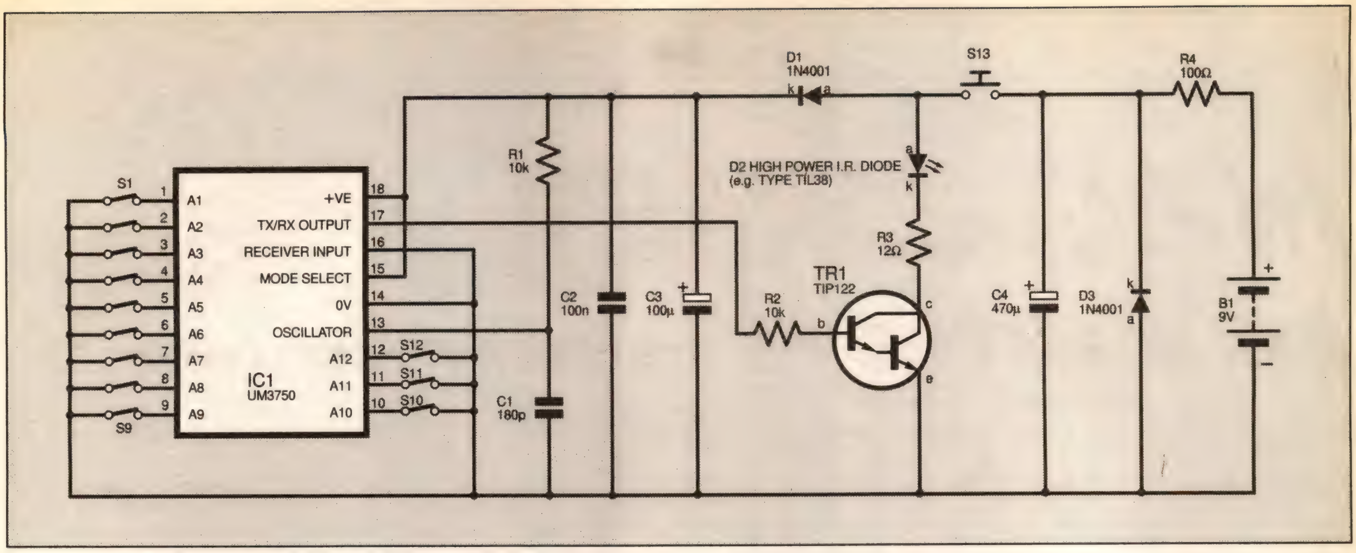


*Fig. 2. Circuit diagram for the Transmitter module.*

## COMPONENTS

### TRANSMITTER

**See SHOP TALK Page**

**Resistors**

| | |
|---|---|
| R1, R2 | 10k (2 off) |
| R3 | 12Ω |
| R4 | 100Ω |

All 0·25W 5% carbon film or better

**Capacitors**

| | |
|---|---|
| C1 | 180p polystyrene |
| C2 | 100n ceramic disc |
| C3 | 100µ elect. axial, 16V |
| C4 | 470µ elec. axial, 16V |

**Semiconductors**

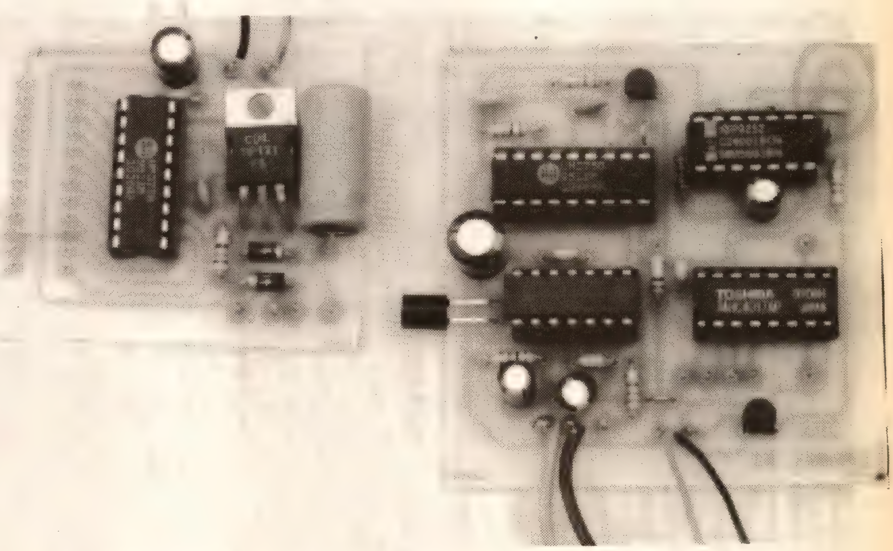
| | |
|---|---|
| D1, D3 | 1N4001 rectifier diode (2 off) |
| D2 | Infra-red l.e.d., high power (e.g. TIL38) |
| TR1 | TIP121 or TIP122 *npn* Darlington transistor |
| IC1 | UM3750 encoder/decoder |

**Miscellaneous**

| | |
|---|---|
| S1 to S12 | see text |
| S13 | push-to-make switch |

Transmitter printed circuit board, available from *EPE PCB Service*, code 981 (see *Shop Talk*); plastic case 100mm x 60mm x 23mm, with belt clip (see text); gun-shaped case to suit taste (see text and *Shop Talk*); PP3 9V battery and clip; red plastic lens (see text); 18-pin d.i.l. socket; connecting wire; solder, etc.

*Approx cost guidance only* **£8**
*excl. case and battery*



*Assembled p.c.b.s for (left) Transmitter and (right) Receiver.*

It is important to ensure that exactly the same pattern of wire links is used for the Transmitter and the Receiver, i.e. the Transmitted code must be identical to the code being sought by the Receiver. The printed circuit board (p.c.b.) design does not allow easy access to switch positions S1 to S9 since this number of combinations is not required, and so the actual code is set up on positions S10 to S12.

When the code is not being received, IC2 pin 17 is high (positive). The output from pin 17 is fed via limiting resistor R3 to the base (b) of transistor TR1 (a processor module technique discussed in Part 1 – Fig. 1.5). The effect of TR1 is to invert the output from pin 17. So, when pin 17 is high, the output from the collector (c) of TR1 is low (about 0V) and, therefore, IC3 pin 1 is low.

When the correct code is received by the circuit, IC2 pin 17 switches from high to low. As a result, TR1 is switched off and its collector voltage changes from 0V to positive, which in turn triggers the monostable comprised of NOR gates IC3a and IC3b. This monostable module was described in Part 2 (Fig. 2.8 and Fig. 2.9).

The values of resistor R5 and capacitor C6 set the time for which the monostable output (IC3b pin 4) stays high. The output from the monostable is delivered via resistor R6 to the base of TR2 (another output module discussed in Part 1 – Fig. 1.13a) to drive the buzzer WD1.

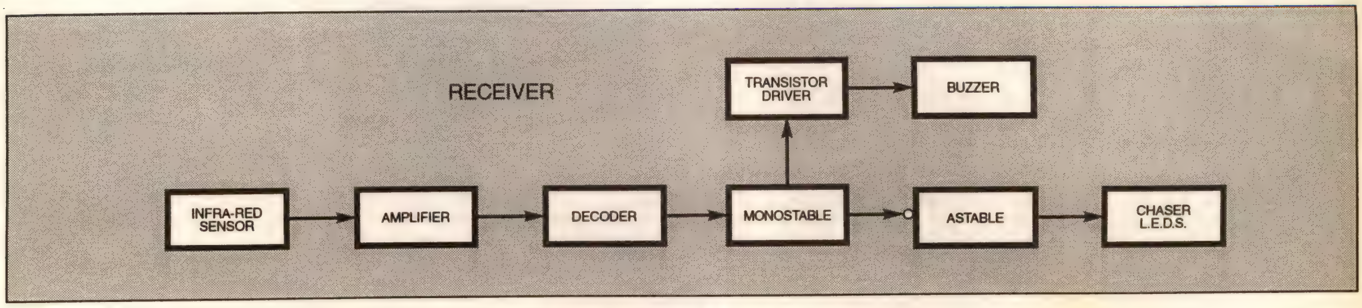


*Fig. 3. Block diagram for the Receiver.*

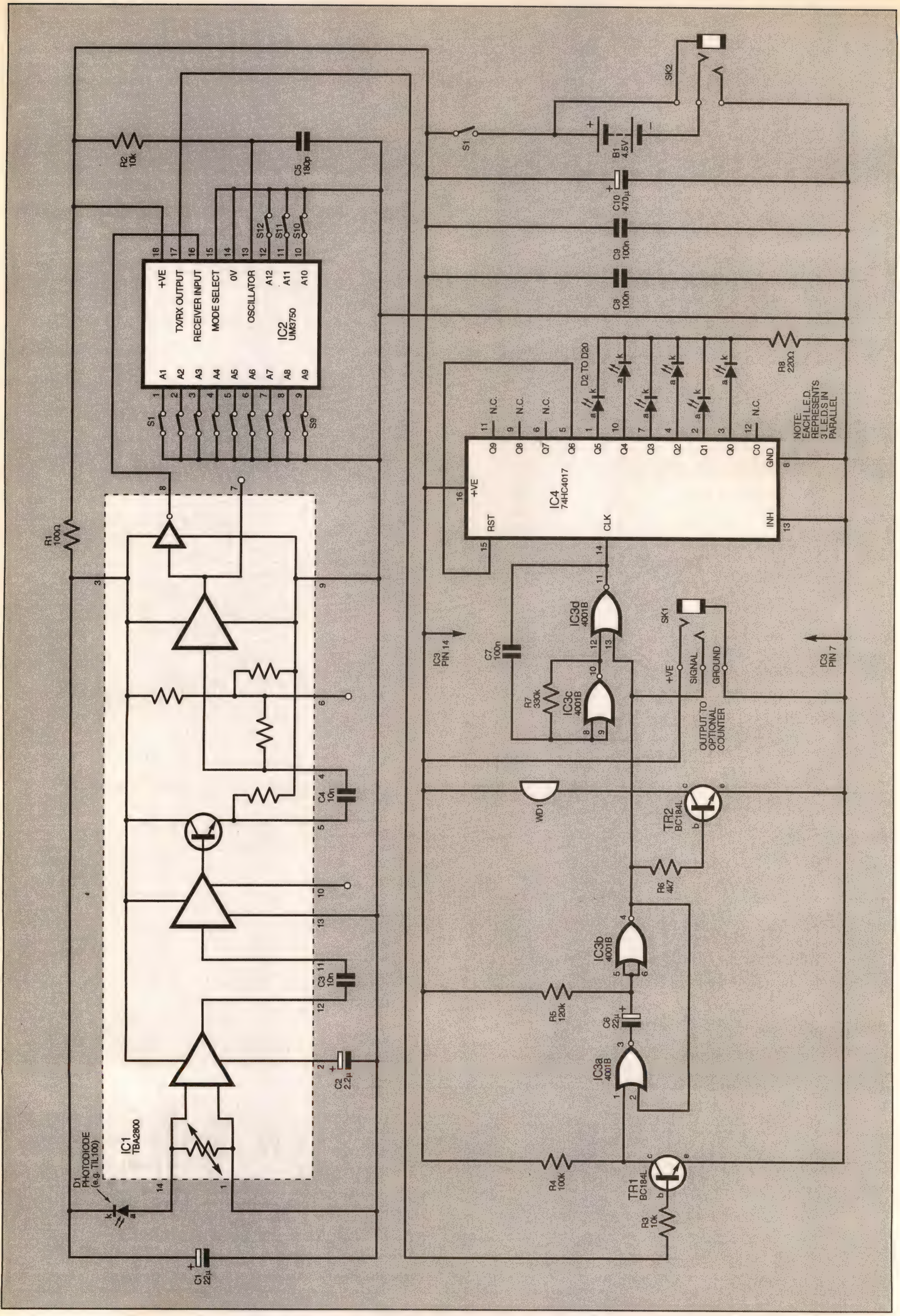


*Fig. 4. Circuit diagram for the complete Receiver module.*

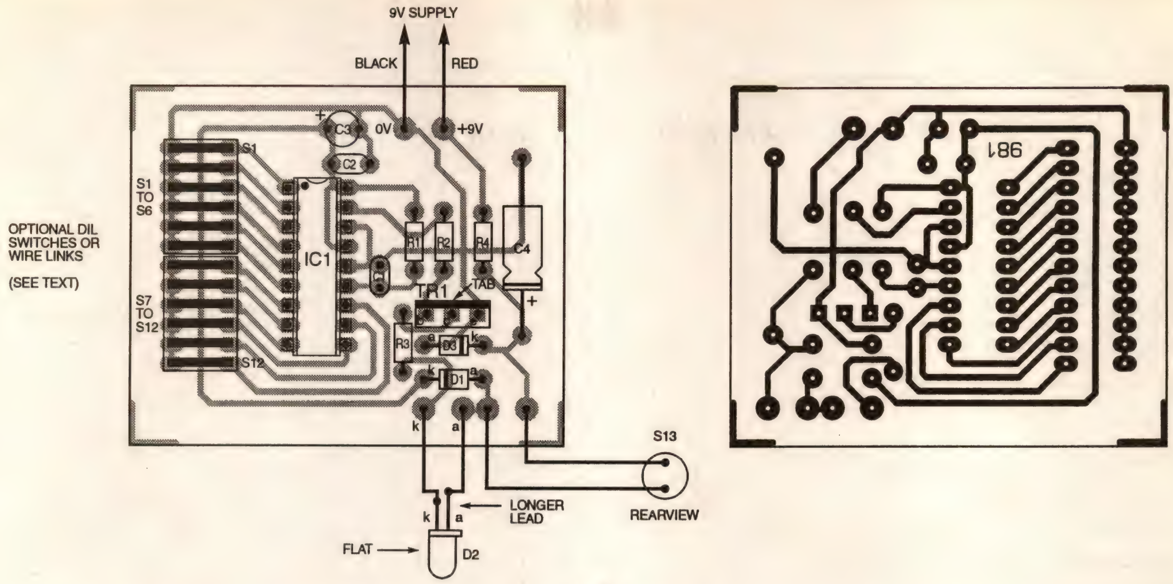


*Fig. 5. Transmitter p.c.b. component layout and full-size underside copper foil track master pattern.*

## COMPONENTS

### RECEIVER

**See SHOP TALK Page**

**Resistors**

| | |
|---|---|
| R1 | 100Ω |
| R2, R3 | 10k (2 off) |
| R4 | 100k |
| R5 | 120k |
| R6 | 4k7 |
| R7 | 330k |
| R8 | 220Ω |

All 0·25W 5% carbon film or better

**Capacitors**

| | |
|---|---|
| C1, C6 | 22µ elect. radial, 16V (2 off) |
| C2 | 2µ2 elect. radial, 63V |
| C3, C4 | 10n ceramic disc (2 off) |
| C7 to C9 | 100n ceramic disc (3 off) |
| C5 | 180p polystyrene |
| C10 | 470µ radial elect., 16V |

**Semiconductors**

| | |
|---|---|
| D1 | TIL100 infra-red receiver |
| D2 to D20 | round l.e.d.s, (6 off each of 3 colours) |
| TR1, TR2 | BC184L transistor (2 off) |
| IC1 | TBA2800 infra-red receiver/amplifier |
| IC2 | UM3750 encoder/decoder |
| IC3 | 4001B quad 2-input NOR gate |
| IC4 | 74HC4017 decade counter |

**Miscellaneous**

| | |
|---|---|
| WD1 | solid state buzzer or piezo sounder |
| S1 | s.p.s.t. on/off switch |

Receiver printed circuit board, available from the *EPE PCB Service*, code 982 (see *Shop Talk*); 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket; 18-pin d.i.l. socket; AA size battery (3 off); 3 x AA size battery holder; plastic case 150mm x 90mm x 54mm; power supply socket (SK2) (see text); stereo 3·5mm jack socket (SK1) (see text); red plastic lens (see text); connecting wire; solder, etc.

*Approx cost guidance only* **£15** *excl. case and batteries*

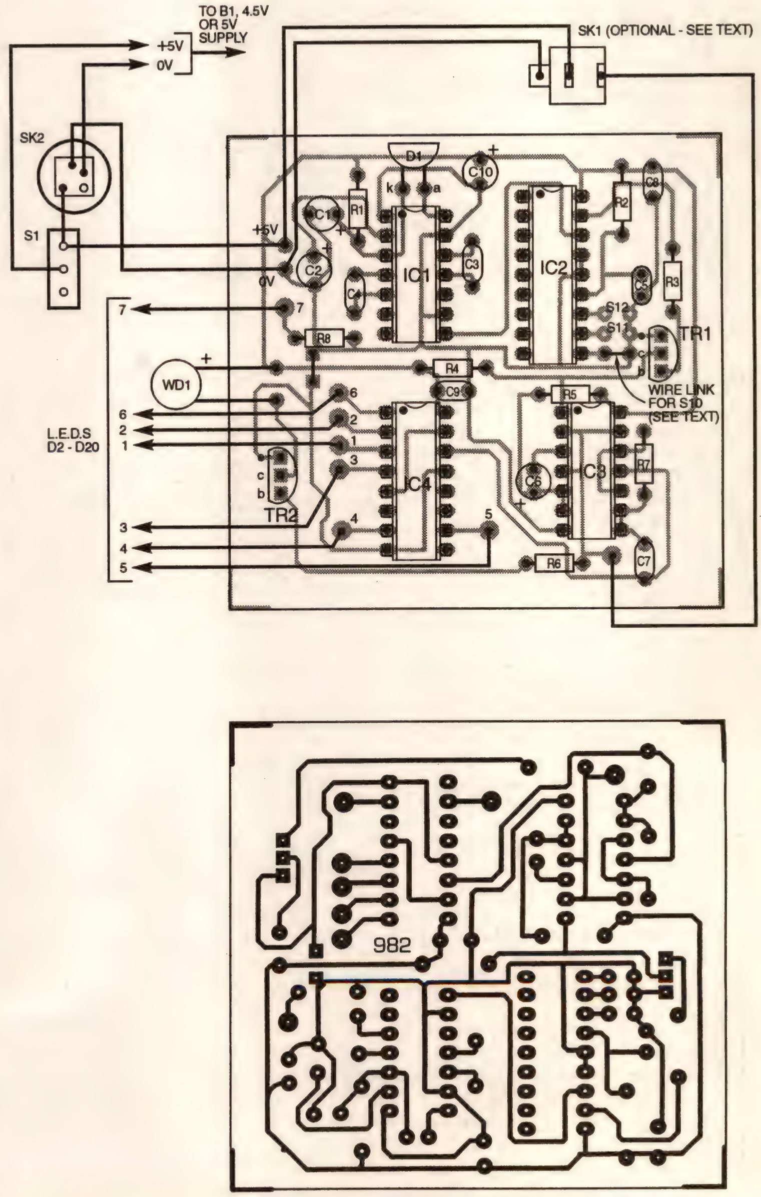


*Fig. 6. Receiver p.c.b. component layout and full-size underside copper foil track master pattern.*

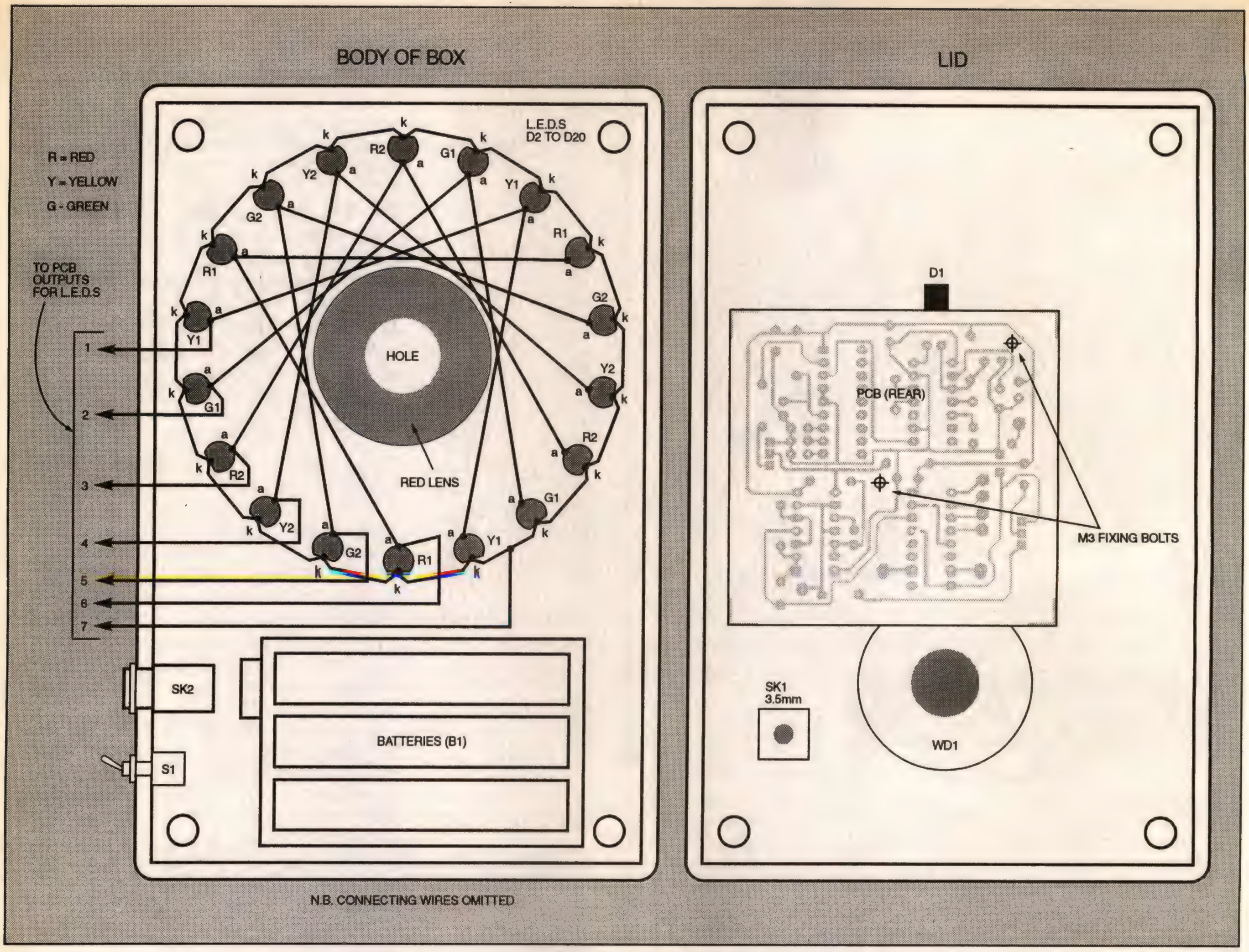


*Fig. 7. Interior layout of Receiver case, showing interwiring of l.e.d.s.*

The monostable output is also fed to IC3d pin 13. Both NOR gates IC3c and IC3d form the astable (see Part 4, Fig. 4.2) which is normally allowed to oscillate. The frequency of oscillation is determined by R7 and C7. When the output from the monostable goes high, the astable is "jammed".

In Part 4, the problem of this type of astable "jamming" when power is first applied was discussed (Fig. 4.5). However, in this circuit the problem is unlikely to occur since the monostable is likely to apply a pulse when first switched on, and in any case the "jam" would clear at the first "hit". Consequently, additional "kick-start" components are not needed here.

The output from the astable, IC3d pin 11, is delivered to the clock input, pin 14, of IC4. The circuit around IC4 is the decade counter described in Part 4, Fig. 4.12.

Only six counter outputs are used to drive l.e.d.s, the seventh (pin 5) being used to reset the i.c. so that the l.e.d.s light in a repeated sequence with no gaps. Six l.e.d.s are shown in the diagram, but in practice a larger number may be used if they are a multiple of six. In the prototype, 18 l.e.d.s were used (notated as D2 to D20 in Fig. 4), an additional two l.e.d.s being wired in parallel with each of the l.e.d.s shown.

Decoupling is provided by capacitors C8, C9 and C10, the first two of them (C8 and C9) are placed in different positions on the p.c.b. to decouple their nearby circuits.

Note the use of a 4·5V battery rather than a 9V or 12V. IC1 *must not* be used on a supply of more than 5·5V, due to the limitations of IC1. It would have been possible to drive the circuit from a 12V supply, with a 5V regulator supplying power to IC1 and IC2. However, there was no need in this application.

## EXTERNAL INTERFACING

The inclusion of socket SK1 in Fig. 4 allows other modules to be connected and triggered by each "hit". A particularly useful module to connect is the *Event Counter* to be described in Part 6.

Two versions of an Event Counter will be discussed in Part 6: one is a full circuit with a liquid crystal display, the other is based on a ready-made module which only requires a simple interface circuit.

It is advisable to operate the counters from the same supply as the receiver, which is also available from SK1.

## CONSTRUCTION

Complete details of the printed circuit boards for the Transmitter and Receiver are shown in Fig. 5 and Fig. 6. These boards are available from the *EPE PCB Service* as a pair, codes 981/982.

Begin construction of the p.c.b.s by inserting the i.c. sockets, checking that their notches agree with the diagrams. Although the i.c. sockets do not *have* to be fitted the correct way round, the notch serves as an indicator to help insert each i.c. correctly. Do not fit the i.c.s yet!

A careful look at the Receiver p.c.b. near the region of IC2 shows that only the last three "switch" links (S10 to S12) are available for coding use. The others were omitted to save space on the p.c.b. and, since this project is not intended to be part of a security system, the limited number of codes so provided is acceptable.

However, the Transmitter p.c.b. contains pads to allow connections to be made to all twelve coding positions, spaced to accept wire links or d.i.l. (dual-in-line) p.c.b. mounting switches. This provides greater flexibility and allows the Transmitter to be used as a remote control unit and/or zapper.

Continue building the p.c.b.s, inserting, say, just one link on the Transmitter, in position S10, S11 or S12, and matching this with a wire link in the equivalent position on the Receiver. In the prototype, position S10 was selected for the wire link on both boards.

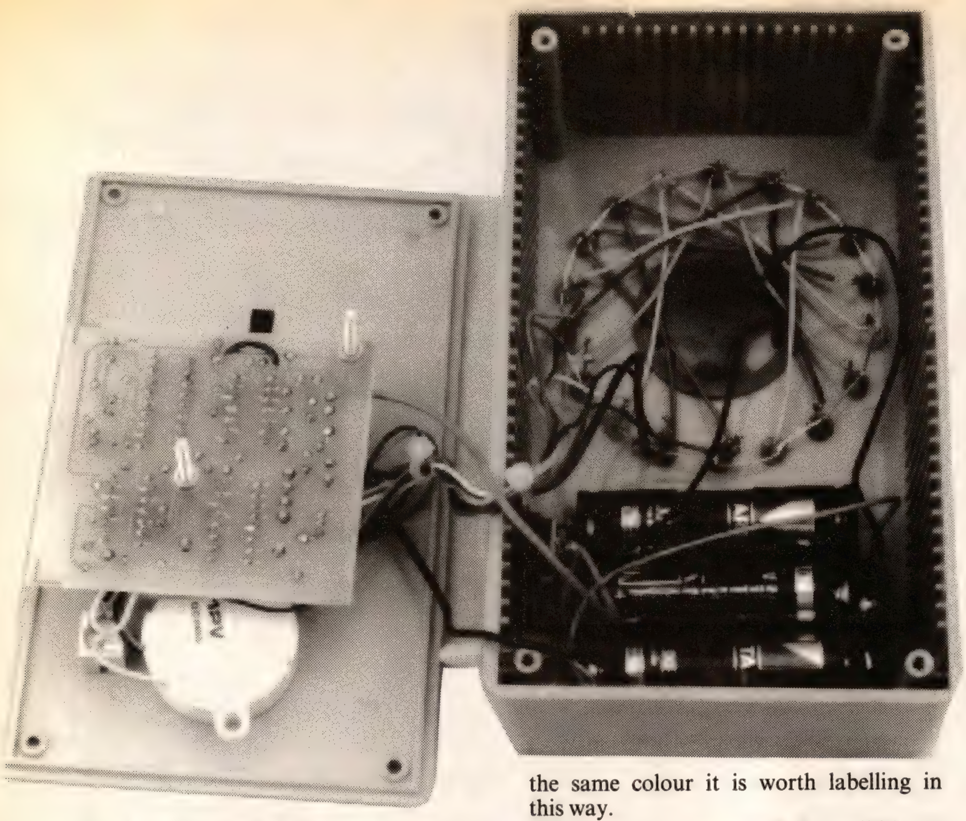
Check that diodes, transistors and electrolytic capacitors are fitted the correct way round, and insert terminal pins for all the external connections.

Pay great attention to fitting the IR sensor D1 the correct way round on the Receiver p.c.b. It can be mounted directly to the p.c.b., soldering it to leave its leads as long as possible between the sensor body and p.c.b. It should then be bent over the edge as shown in Fig. 7, facing upwards towards the target hole in the case.

The infra-red l.e.d. on the Transmitter can be soldered temporarily to its terminal pins for testing. Later, a longer pair of wires will connect the l.e.d. output to the "gun".

## RECEIVER CASE

It is much easier to mount the l.e.d.s in the Receiver case before attempting to connect them to the p.c.b. Since this involves drilling the case, it is wise to drill all the



other holes required at the same time. It is worth taking care with the drilling, to obtain a good circle.

Have an enlargement photocopy made of Fig. 7 and use it as a lifesize template. The enlargement required is about 123 per cent. Using a small drill first, carefully drill a hole at each l.e.d. position. Then use the correct size drill to suit the l.e.d.s themselves.

Drill a hole in the case body for the IR beam to pass through to the sensor, and possibly a hole in the lid for the sound of the buzzer to escape.

Drill other holes in the body for the on/off toggle switch S1, an audio power socket (SK2) if an external power supply is required, and add a hole in the lid or body for a 3·5mm stereo jack socket (SK1) if connection to the *Event Counter* in Part 6 will be required.

The p.c.b. may be mounted on the lid by means of two M3 bolts and spacers with the copper side towards the l.e.d. display. This allows the sensitive surface of the IR sensor to face the red lens.

## L.E.D. MOUNTING

When drilling is complete, mount the l.e.d.s in the case as shown in Fig. 7. While inserting them into their holes, try to keep all the longer leads on the inside of the circle. This will help the wiring operation.

Bend each of the shorter cathode (k) leads towards the outside of the circle and towards the next l.e.d. in the circle. It should be possible to connect all the shorter leads together by careful bending and soldering to form a complete ring of wire.

The longer anode (a) l.e.d. leads are more complicated. Each l.e.d. must be connected to the seventh l.e.d. from it around the circle. If three l.e.d. colours have been used, as recommended, such as yellow, green and red, then the operation is more obvious, especially if they are carefully placed in sequence and labelled G1, Y1, R1, G2, Y2, R2, and then back to G1, Y1, R1, etc., as shown in Fig. 7.

Connect together the three anodes of the l.e.d.s labelled Y1, the three anodes labelled G1, etc. Even if all the l.e.d.s are the same colour it is worth labelling in this way.

Six leads (colour coded if possible) are then used to connect these commoned anode groups to the p.c.b. Don't forget to add one extra lead from the cathode side of the l.e.d.s back to the p.c.b.

Complete the other external connections. If in doubt when the optional power supply socket (SK2) is fitted, use a meter to confirm the connections so that the battery automatically disconnects when external power is applied.

If the optional 3·5mm stereo jack socket (SK1) is fitted for an external counter, note that in the prototype, and as shown in Fig. 6, the screen pin of the socket was connected to 0V, the right hand stereo channel to positive, and its tip (left hand stereo channel) to the output pad next to R6 on the p.c.b. This allows the counter to be powered from the Infra-Zapper's power supply.

**Do not use a mono jack plug with the stereo socket, or a short circuit may occur.**

Connect the 9V PP3 battery clip to the Transmitter p.c.b. Finally, insert all the i.c.s into their sockets, taking care to install them the correct way round, and taking the usual precautions regarding static charge.

In other words, briefly earth yourself by touching an earthed metal object (e.g. the metal case of an appliance plugged into the mains supply), and do not walk over a nylon carpet before handling the i.c.s.

Once installed into their sockets, under normal circumstances the components in the rest of the circuit will provide all the necessary protection.

## TESTING

When power is applied to the Receiver, the l.e.d. sequence display should appear to rotate. Failure of some of the l.e.d.s to light indicates faulty wiring somewhere around the circle. Failure of all the l.e.d.s to light indicates a serious problem!

Assuming all is well, try aiming the Transmitter at the Receiver. Hold the Transmitter a metre or more from the Receiver and press the trigger button. The l.e.d.s should stop rotating and the buzzer should sound. Note that stray IR reflections can upset reception of the code.

The Receiver may work more reliably if some black paper is placed on the test bench. Alternatively, place the Receiver near the edge of a table. When the system is installed in the case, reflections should not be a problem.

## FAULT FINDING

A general guide to fault finding was provided at the end of Part 1. As stated in Part 5, infra-red systems can be frustrating, particularly if it is not clear whether the Transmitter or Receiver is at fault.

An oscilloscope will detect the presence of a signal at the anode (a) of the IR sensor, i.e. the side connected to IC1 pin 14. If no signal is detected, try any remote control transmitter; a signal should be detectable by an oscilloscope even though it cannot be decoded. It is possible to trace the signal through the i.c. by touching the 'scope probe on IC1 pins 12, 11, 5, and 4 in turn.

Once the signal is decoded in the Receiver by IC2, simple voltmeter tests may be used to check for faults. For example, connect the voltmeter to the collector of the transistor TR1, and/or IC3 pin 1. Force the base of TR1 low by shorting it to the 0V line. The collector should switch to positive each time the base is made 0V.

Repeat the shorting action, but now check the voltage at the output of the monostable, IC3b pin 4. This should switch to positive for a fixed time after the base of TR1 is connected to 0V. Check that this is copied at IC3d pin 13.

Check the voltage at IC4 pin 14. An oscilloscope should display a square wave unless the monostable is triggered. A voltmeter will give a rather flickery voltage around half the supply. If the voltage at pin 14 is either fully positive or 0V, try forcing it high or low (briefly connect a wire between it and one of the power rails) and see if the display moves on by one step.

This "forcing" may sound dangerous to IC3d, but in practice the outputs of CMOS gates will tolerate a short circuit for a short time! If courage is lacked about treating IC3 in this way, remove it first.

Fault finding the Transmitter is difficult without an oscilloscope and is largely confined to visual checking. An oscilloscope will indicate the production of a signal at

IC1 pin 17 when the trigger switch S13 is pressed. This signal should also be present at the collector of transistor TR1 in that circuit (Fig. 2).

## RECEIVER HOUSING

Once the Receiver has been tested, it remains to fix in place the battery box, optional power socket and toggle switch in the body of the case, plus the p.c.b., buzzer and optional 3·5mm stereo jack in the lid.

The p.c.b. should be mounted so that the IR sensor is directly in line with the centre of the l.e.d. circle. A red lens may be glued behind the hole in the centre to create a neater effect. However, it makes only a marginal difference to the working of the project.

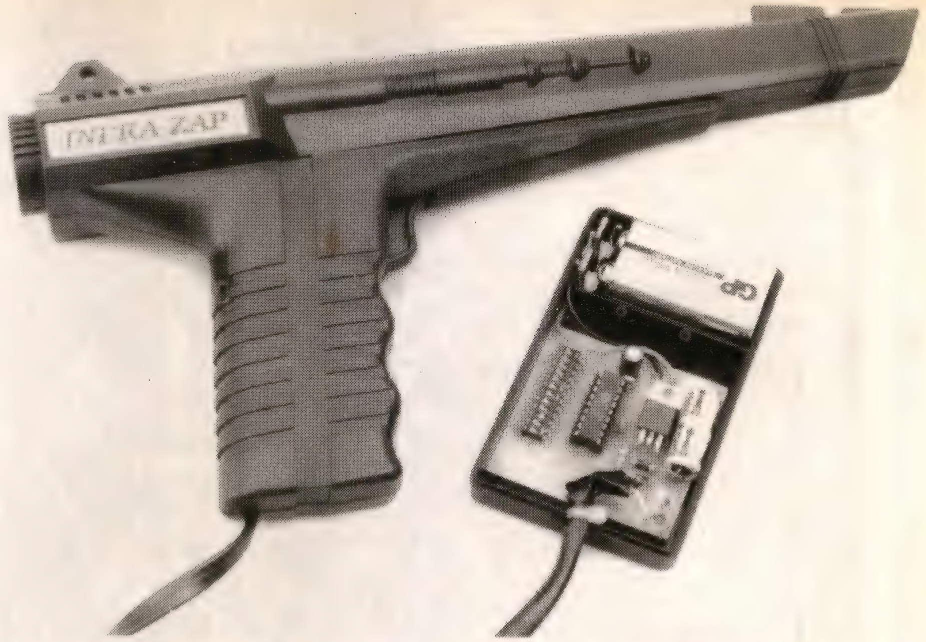
## TRANSMITTER HOUSING

A gun-like case is ideal for this project. The prototype used a gun which was originally part of a TV game. If one is not already owned, a trip to the local toy shop should produce a low cost gun-like item.

The gun case was opened and the infra-red l.e.d. inserted, together with a small lens to focus the beam. Some experimentation is required since the lens makes only a marginal difference to the operation of the system.

The Transmitter p.c.b. itself may or may not fit inside the gun. The prototype p.c.b. is housed in a small case intended for use as a remote control unit. The case has a compartment for a PP3 battery and a belt clip. A 4-core wire connects the circuit with the gun: two wires for the infra-red l.e.d. and two for switch S13, which should be linked to the trigger of the gun.

Note that a 3-core wire will suffice since the anode of the l.e.d. is the same electrical connection as the lower side (as on Fig. 5) of S13.



## PART SIX

Accompanying *Teach-In* Part 6 as the illustrative projects are two Event Counter modules which, among other functions, can be linked with the Infra-Zapper to indicate your score. Happy zapping!

---

# SHOP TALK

## with David Barrington

### High Current Stabilized Power Supply

Although there is not an abundance of components in the *High Current Stabilized Power Supply*, one or two of them will need selecting with care if the cost is to be kept to a minimum. The main smoothing capacitor C1 should have a minimum capacity of 22,000µF and be rated with at least a figure of 10A "ripple current".

The capacitor appears to be the most expensive item in this project and shopping around has produced prices from around £16 to well over £30.

The next most expensive, and probably the most important, is the 120VA toroidal transformer. Once again prices do vary, the one in the model was purchased from **Electrovalue** (☎ *01784 433603)*, code T12015 for the sum of £12.23 plus VAT. A post and packing charge will also be made. Note that the leads from the two 15V secondaries must be paralleled together in this design.

The 10-pin metal can voltage regulator type L123, which may be hard to find locally, in currently listed by **Electromail** (☎ *01536 204555)*, code 305-440. You can if you wish, use the more readily available *14-pin d.i.l.* version type LM723. You will, of course, have to adapt the p.c.b. to take this i.c. if you opt for the 14-pin version.

If any readers have difficulty in finding a suitably rated bridge rectifier, **Maplin** stock one, code BH47B. They also stock a suitable small TO220 heatsink for TR3, code JW28F, if you do not want to make your own.

The large power heatsink should be readily available from most of our component advertisers. The price may vary from shop to shop and it is claimed that a plain aluminium, unanodised and undrilled one will cost about half as much (we have not been able to find one).

### Mind Machine Mk III

We do not expect any buying problems to be encountered by readers tackling the *Mind Machine Mk III* project. Most components should be "off-the-shelf" devices.

Almost any 100µH inductor will do the job of L1 in this circuit, but wire-ended types are easier to accommodate on the p.c.b. and have a reasonable operating tolerance of about 10 per cent. The one used in the prototype is an r.f. type and was ordered from **Maplin**, code WH41U.

The "Hyperbright" l.e.d.s gave the best performance and should be used if possible. These also came from the above source, code UK20W.

Finally, all readers must heed the "warning panel" in the article about possible side effects when using the unit.

### Multi-Purpose Mini Amplifier

No problems should arise when ordering parts for the *Multi-Purpose Mini Amplifier.* This project was specially designed for headphone operation (including the Free ones banded to UK copies) and will accept inputs from most sound equipment.

The output jack socket in the model is a miniature, metal bodied, stereo type and the output leads are soldered to the channel tags only, the common (body) connection being left free.

### Infra-Zapper (Teach-In '96)

Most components advertisers will either stock the specified infra-red l.e.d. and detector diode or be able to offer suitable equivalents for the *Infra-Zapper*, this month's *Teach-In* project. If maximum range is important it is worth experimenting with alternative IR transmitting l.e.d.s.

The UM3750 encoder/decoder used in the Transmitter and Receiver came from Maplin, code UK77J. The "hip" mounting case (KL95D) and the "target" case (YU54J) were purchased from the same source. The prototype plastic "gun" originally came from **Bull Electrical** (☎ *01273 203500)*. No doubt, most local toy shops will stock a suitable plastic gun.

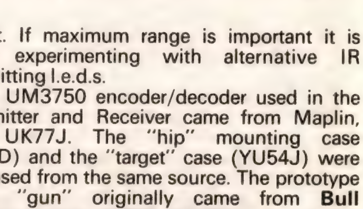
### PIC-Electric Meter

All the "hard to find" components for the PIC-Electric Meter were covered in last month's article. As a point of interest, readers who buy the ready-programmed PIC from **Magenta Electronics** do not need to possess a computer to build this project.

The source-code listing is obtainable on a 3·5in Disk (together with the SImple PIC Programmer (last month) software) from the Editorial Offices (see page 181 for address) for £2.50 (overseas – surface £3.10; airmail £4.10). Please note that there is a minium order charge of £5 levied for Credit Card transactions.

All the printed circuit boards for this month's project are available from the *EPE PCB Service* – see page 243.

HIGH QUALITY LOW COST
C.C.T.V. CAMERA
VERY LOW LIGHT LEVEL.
AUTO ELECTRONIC SHUTTER.
COMPOSITE VIDEO OUT VIA BNC PLUG.
SMALL DISCRETE SIZE.
CAN BE USED WITH PC DIGITISER.



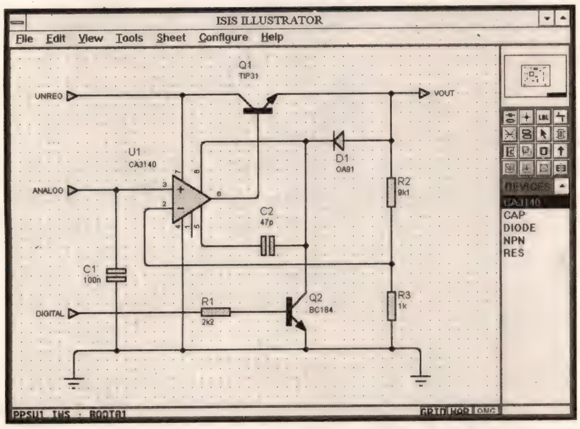
This super quality CCD camera can be connected into your existing TV or video using the AV channel and can be used for discrete surveillance or observing your property externally using a suitable weatherproof housing. Can accommodate lighting levels ranging from daylight to street lighting using its built in electronic shutter. Excellent when using with an infra red source. Built in wide angle fixed focus lens the camera has a resolution of 380 TVL. Can be housed inside an empty floodlight case, (extra).

Special offer price of only: **£79.95 Plus VAT (P&P £3.50)**
**For full range of CCTV products send SAE to:**
**Direct CCTV Ltd., Dept. PE27., Unit 6, Carrick Court, Forrest Grove Business Park, Middlesbrough, TS2 1QE.**

# PROFESSIONAL CIRCUIT AND PCB DESIGN AIDS FOR WINDOWS

## CADPAK for Windows

*CADPAK is especially suited to educational, hobby and small scale schematic and PCB design. CADPAK includes both schematic drawing and 32-bit PCB drafting tools but as an entry level product, there is no netlist link between them.*



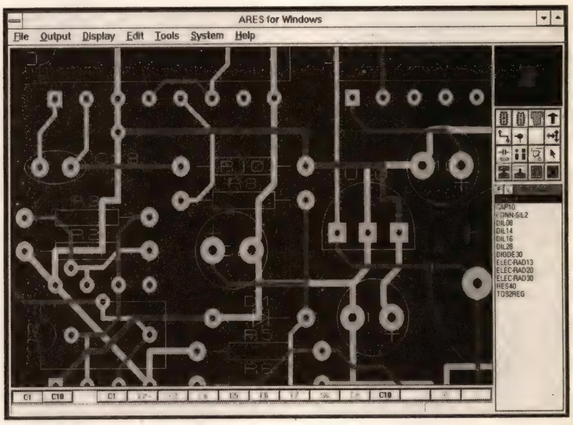
*The schematic drawing module of CADPAK, ISIS Illustrator, enables you to create circuit diagrams like the ones in the magazines.*

- *Runs under Windows 3.1 making full use of Windows features such as on-line help.*
- *Full control of appearance including line widths, fill styles, fonts, colours.*
- *Automatic wire routing & dot placement.*
- *Fully automatic annotator.*
- *Complete with device and comprehensive package libraries for both through hole and SMT parts.*
- *Advanced route editing allows deletion or modification of any section of track.*
- *Gerber, Excellon and DXF outputs as well as output via Windows drivers. Also includes Gerber viewer.*
- *Exports diagrams to other applications via the clipboard.*
- *CADPAK is also available for DOS.*

**CADPAK FOR WINDOWS ........ £ 149**
**CADPAK FOR DOS .................. £ 79**

## PROPAK for Windows

*PROPAK has all of the features in CADPAK plus netlist based integration, automatic power plane generation and a powerful auto-router. PROPAK includes enough schematic capture and PCB design functionality for all but the most demanding applications.*



*PROPAK's schematic drawing editor ISIS ILLUSTRATOR+ includes even more features than ISIS ILLUSTRATOR. PROPAK's 32-bit PCB design tool, ARES for Windows, is our most powerful and easy to use yet.*

- *Multi-sheet and hierarchical designs.*
- *Netlist link between modules guarentees consistency between schematic and PCB.*
- *Netlists are also compatible with SPICE-AGE and most other electronics CAD packages.*
- *Generates a full bill of materials.*
- *ASCII data import facility.*
- *Electrical rules and connectivity checkers.*
- *Ratsnest display with automatic update during placement and routing.*
- *Multi-strategy autorouter gives high completion rates.*
- *Power plane generator creates ground planes with ease.*
- *PROPAK is also available for DOS.*

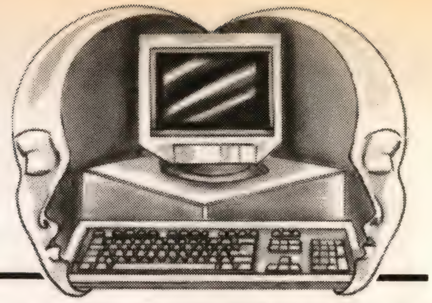
**PROPAK FOR WINDOWS ........... £ 495**
**PROPAK FOR DOS .................... £ 395**

**Call or fax us today for a demo pack. Please state whether you would like a DOS or Windows pack.**

Prices exclude postage (£5 for UK) and VAT. ISIS ILLUSTRATOR and ARES for Windows are also available separately. All manufacturers trademarks acknowledged.

labcenter
*Electronics*
**53-55 Main St. Grassington, N. Yorks. BD23 5AA**
Tel: 01756 753440 Fax: 01756 752857

# INTERFACE



## Robert Penfold

A SIMPLE television style quiz monitor based on a PC was described in a previous *Interface* article. The system described in that article had provision for four pushbutton switches, with each switch monitored via a separate input line of the printer port.

It would not be difficult to extent the original system to accommodate more switches, but more input lines would be required. In fact a lot more input lines could be required. As an example, on the basis of one input line per pushbutton switch, four teams of four players would require some 16 input lines.

It would be possible to use standard multiplexing techniques to provide 16 inputs via the printer port, but a proper PIO card would probably be a better way of providing the input lines. Fortunately, there are simpler and less expensive means of monitoring numerous switches.

Probably the most simple method is to use a scanning technique. This is basically the same method that is used in many computer keyboard circuits.

The scanning system described here can monitor up to 16 switches, and it is presented as a 16-Station Quiz Monitor. However, the hardware should be usable in practically any situation where up to 16 pushbutton switches, microswitches, etc. must be monitored.

### Ins and Outs

This system is based on a CMOS 4514BE four-to-16 line decoder. Pinout details for the 4514BE are given in Fig. 1.

There are 16 output pins ("Out 0" to "Out 15"), and only one of these is high at any one time. The required output is set high by feeding the appropriate four-bit binary value to the data inputs ("D0" to "D3"). For example, a binary value of 0110 (equivalent to 6 in decimal) would set Out 6 (pin 5) high.

The 4514BE has two control inputs, one of which is an Inhibit input (pin 23). This is taken low for normal operation, or high to switch off all the outputs.

The Strobe input at pin 1 can be used to latch data into the transparent latch at the four data inputs. Data is latched by taking pin 1 through a high to low transition. If the latching facility is not required, the latch can be made "transparent" by holding pin 1 high.

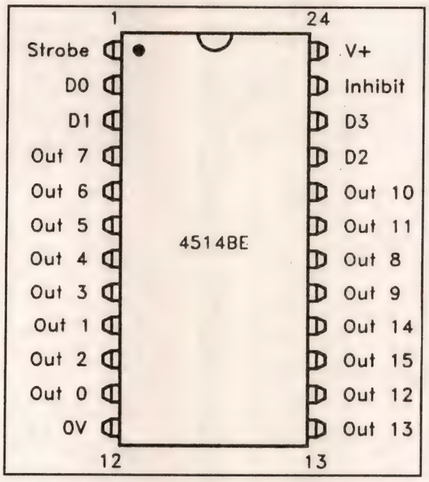


*Fig. 1. Pinout details for the 4514BE four-to-16 line decoder.*

### One-by-One

On the face of it the 4514BE is of little use in the current context, as it gives 16 outputs from four inputs. We require something that provides the opposite action, with 16 inputs being multiplexed down to four outputs. The 4514BE can in fact provide the required action, but only in conjunction with a digital input line and some simple gating.

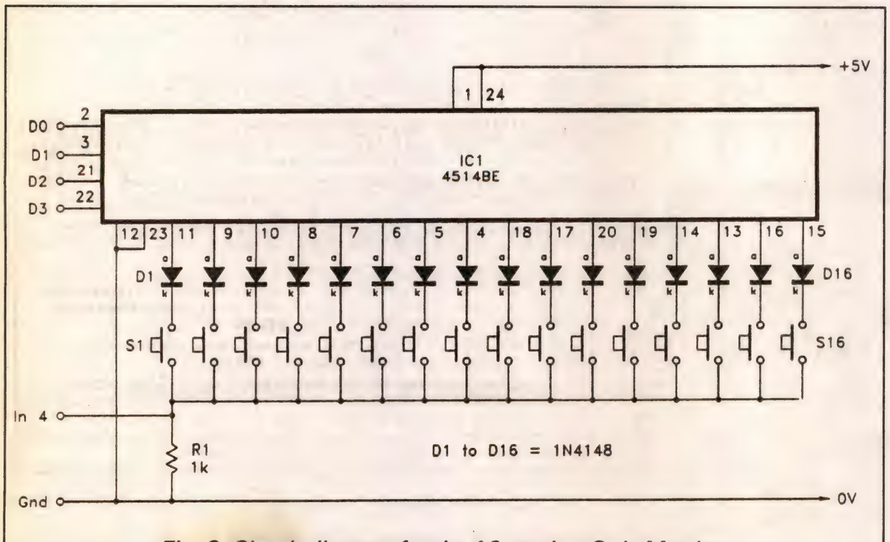


*Fig. 2. Circuit diagram for the 16-station Quiz Monitor.*

Four outputs and one input line are well within the limits of the PC printer ports. The circuit diagram for the 16-Station Quiz Monitor appears in Fig. 2.

The inhibit and latching facilities are not required in this case. Consequently, pin 1 is taken high and pin 23 is tied to the 0V supply rail.

The four data inputs of IC1 are fed from the four least significant data outputs of the printer port. These are at address &H378 for printer port 1, and &H278 for printer port 2. S1 to S16 are the push-button switches, and diodes D1 to D16 provide the gating.

An output that is high can take the input line high if the corresponding push-button switch is closed, but an output that is low cannot hold the input line low. The input line is provided by one of the printer port's handshake inputs. This line is bit 4 at address &H379 for port 1, or &H279 for port 2. Under standby conditions this line is taken low by resistor R1.

### Action Stations

The basic action of the software is to first write a value of zero to IC1, and then check to see if the input line has been taken high. This can only occur if push switch S1 is closed. It then connects output 0 of IC1 to the input line via diode D1.

Next a value of one is written to IC1, which sets output 1 high. The input line is then checked again, and it will only be high if switch S2 is closed.

This process is continued, with the value written to IC1 being raised by one, and the input line checked, until a value of 15 has been used. At this point switches S1 to S16 have all been checked, one-by-one.

This process is repeated until one of the switches is closed. The software detects that the switch has been closed the next time that particular switch is scanned. In a quiz monitor application the software must then indicate which switch has been activated, and then wait for the quiz master to reset the system.

Details of the connections to the printer port are provided in Fig. 3. The connections to the computer are made via a 25-way male D-type connector.

### Software

The accompanying program listing is for a basic 16 station quiz monitor. Line 20 clears the screen, and the next two lines print a couple of on-screen instructions.

These are simply to press the "R" key to Reset the system after a key press has

**Listing 1: 16-Station Quiz Monitor**

```
10  REM 16 Station Quiz Monitor Program
20  CLS
30  PRINT "Press 'R' Key To Reset Monitor"
40  PRINT "Press 'S' Key To Stop Program"
50  PORT = &H378
60  SWITCH = &H379
70  OUT PORT,0
80  IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 1 Pressed"
90  IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
100 OUT PORT,1
110 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 2 Pressed"
120 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
130 OUT PORT,2
140 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 3 Pressed"
150 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
160 OUT PORT,3
170 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 4 Pressed"
180 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
190 OUT PORT,4
200 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 5 Pressed"
210 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
220 OUT PORT,5
230 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 6 Pressed"
240 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
250 OUT PORT,6
260 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 7 Pressed"
270 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
280 OUT PORT,7
290 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 8 Pressed"
300 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
310 OUT PORT,8
320 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 9 Pressed"
330 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
340 OUT PORT,9
350 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 10 Pressed"
360 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
370 OUT PORT,10
380 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 11 Pressed"
390 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
400 OUT PORT,11
410 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 12 Pressed"
420 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
430 OUT PORT,12
440 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 13 Pressed"
450 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
460 OUT PORT,13
470 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 14 Pressed"
480 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
490 OUT PORT,14
500 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 15 Pressed"
510 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
520 OUT PORT,15
530 IF (INP(SWITCH) AND 16) = 16 THEN PRINT "Player 16 Pressed"
540 IF (INP(SWITCH) AND 16) = 16 THEN GOSUB 560
550 GOTO 70
560 A$ = INKEY$
570 IF A$ = "r" THEN GOTO 600
580 IF A$ = "s" THEN END
590 GOTO 560
600 CLS
610 RETURN
```

been detected, and to press the "S" key to stop the program. Note that the program can only been halted after a pushbutton has been operated, and the program has branched out of the main loop.

Lines 50 and 60 set variables "PORT" and "SWITCH" at values of &H378 and &H379 respectively. These are the addresses of the output port and the input line, and are correct for printer port 1.

If you will be using port 2 these values should be changed to &H278 and &H279 respectively. No other changes should be required.

The main program is the loop from lines 70 to 550. This scans the switches, and prints an appropriate on-screen message when a switch is operated. Also, whichever switch is operated, the program branches to the subroutine at lines 560 to 610.

The program loops around lines 560 to 590 until either the "R" or "S" key is pressed. Line 580 brings the program to a halt if the "S" key is operated. If the "R" key is operated, the program branches from line 570 to line 600. Here the screen is cleared, and then the program returns to the main loop.

The program is written in such a way that there can never be a "dead heat" if two switches are pressed more or less simultaneously. Although it might appear as though the scanning process favours low switch numbers, bear in mind that the scanning count could be at any value when two or more switches are activated.

Which switch "wins" is therefore purely random, with the system having no built-in bias. Of course, the faster your PC, the better the system is able to pick the correct switch when two or more are pressed almost together.

With a reasonably fast PC each complete scan should take under a millisecond. This should give fine enough resolution to ensure fair results.

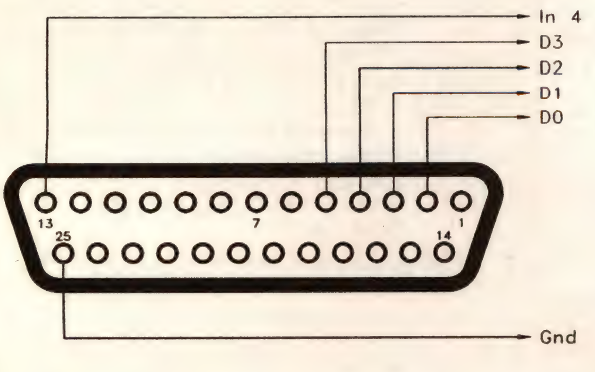


*Fig. 3. Details of the connections to the PC printer port.*

**PIC EEZE**

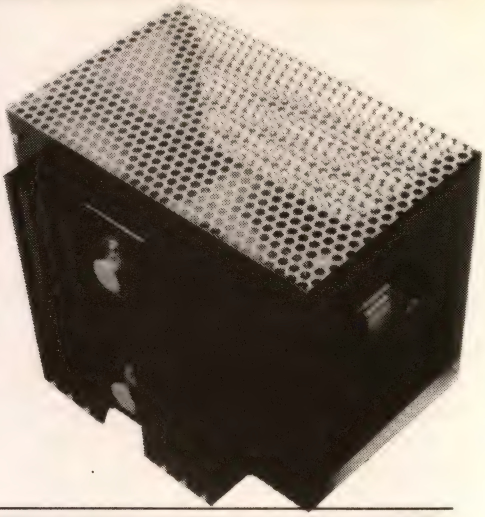
**This is the easiest way to start using PIC microcontrollers. PIC EEZE is a modular that allows a cheap entry level which builds into a powerful and verstaile development platform.**

**PIC EEZE-1** – Supports 16C61/64/71/74/84 and serial EEPROMS and LPAK. **£44.95**
**PIC EEZE-2** – As above plus supports 16C54/55/56/57/58. **£52.95**
**PIC EEZE-3** – All above plus In Circuit Emulation. **£72.95**
**LPAK** – An introduction to PIC programming. This board plugs into the PIC EEZE system and has on board 7-segment displays, LED's and buttons which can be controlled via software to show simple PIC programming for beginners. **£28.00**
**DPAK** – Demonstration board for 18/28 pin PIC's. Stand alone c/w ready built oscillator, regulation, 7-segment displays, LED's and buttons. **£28.00**

The system can be upgraded when ready. PIC EEZE-1 to PIC-EEZE-2 upgrade **£9.95**, PIC EEZE-1/2 to PIC EEZE-3 upgrade **£29.95.** PIC EEZE is also software upgradeable for future versions of PIC devices, the software will be made available FREE. We also supply PIC's and serial EEPROMS at affordable prices with discounts to our users. The system is being developed further and future FREE software will allow PIC EEZE-2/3 to give PC I/O port and Analogue data logger.
All PIC EEZE systems come complete with assembler, simulator and programming/editing software. A suitable PSU and parallel lead are required, we supply a lead at **£4.00** and a PSU (3/4.5/6/7.5/9/12V @300Ma) at **£4.95.** We will also give any support we can to our users with their PIC projects etc.

Next day response. Please add **£2.00** P&P and make cheques P.O.'s payable to Lennard Research, and [illegible] send to 29 Lavender Gardens, Jesmond, Newcastle upon Tyne NE2 3DD. [illegible] or Telephone (0191) 281 8050 for further details and our range of products price.

# HIGH CURRENT STABILIZED POWER SUPPLY



## STEVE KNIGHT

*A robust stabilized "power broker" that will deliver up to 7·5A. Output voltage can be preset from 12·5V to 16V. Run your 12V equipment from the mains.*

THIS Stablized Power Supply unit, besides being a general purpose high current supply, enables certain battery powered equipment to be operated off the mains rail. This is a useful feature particularly for the indoor operation of otherwise mobile equipment, such as solid state amateur transceivers which normally operate from car battery sources.

This relatively simple design will provide the nominal fully-charged voltage of a battery supply from mains input, and with a current rating sufficient for almost all commonly used equipment. The output is 13·8V up to a current limit of 7·5A, with safety limiting at about 8A, stabilized within 0·2V over the current range. An adjustment is available for setting the output to a voltage level from about 12·5V to 16V if this is required, the current limit and stabilization remaining as before.

The design is developed around the 10-pin L123 metal can voltage regulator i.c., although for those who can design their own board the 14-pin L723 d.i.l. version of this regulator may be used instead. The operating characteristics of both versions are identical except for the power dissipation rating of the metal can which is 800mW against 650mW for the d.i.l. version, but this is of no importance in the present usage.

The pin connections for the metal can version are shown in Fig. 1. It is important to notice that this view is made looking from the *top* of the can, *not* the pin view.

### REGULATION CIRCUIT

The basic internal structure of the L123 voltage regulator i.c. is shown within the broken lines of Fig. 2. This is a quite conventional arrangement; the series emitter-follower transistor TRA is used as the control element between the input voltage point V+ and the output voltage point $V_O$.

The output voltage across the load is sampled at the connecting point of the voltage divider chain R1 and R2 and compared with that of a reference voltage $V_{REF}$ derived from a constant current (Zener) source, this being available at pin 4. By connecting this pin to the non-inverting input of the error amplifier at pin 3, this point is held at the reference level so that a comparison can be made between it and the sampled voltage from the output which is applied to the inverting input via pin 2.

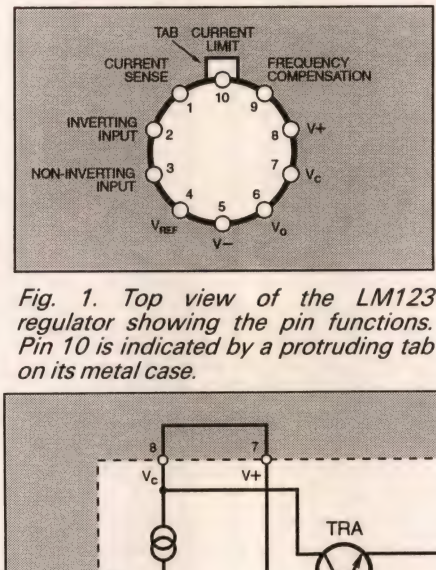


*Fig. 1. Top view of the LM123 regulator showing the pin functions. Pin 10 is indicated by a protruding tab on its metal case.*

Any difference between these voltages is detected by the comparator and after amplification is fed back to the base of the series regulator so as to maintain the output voltage $V_O$ at pin 6 at a constant level.

The direct amplifier output is also available at pin 9; this enables a compensating capacitor *C* to be wired to the inverting input at pin 2 which reduces the amplifier gain at high frequencies and helps to maintain overall stability. Make a point of noticing that the feedback around the control loop is negative.

A protection circuit which operates against the effect of overloading at the output, such as an inadvertant short-circuit, is provided by the internal transistor TRB. The base and emitter connections of this transistor are available at pins 10 (Current Limit) and pin 1 (Current Sense) respectively.

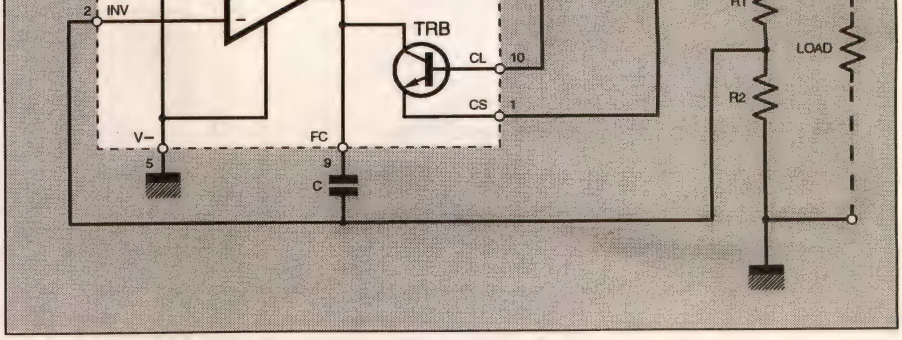


*Fig. 2. The regulator internal structure and essential external connections. The external components are those outside the dashed area.*

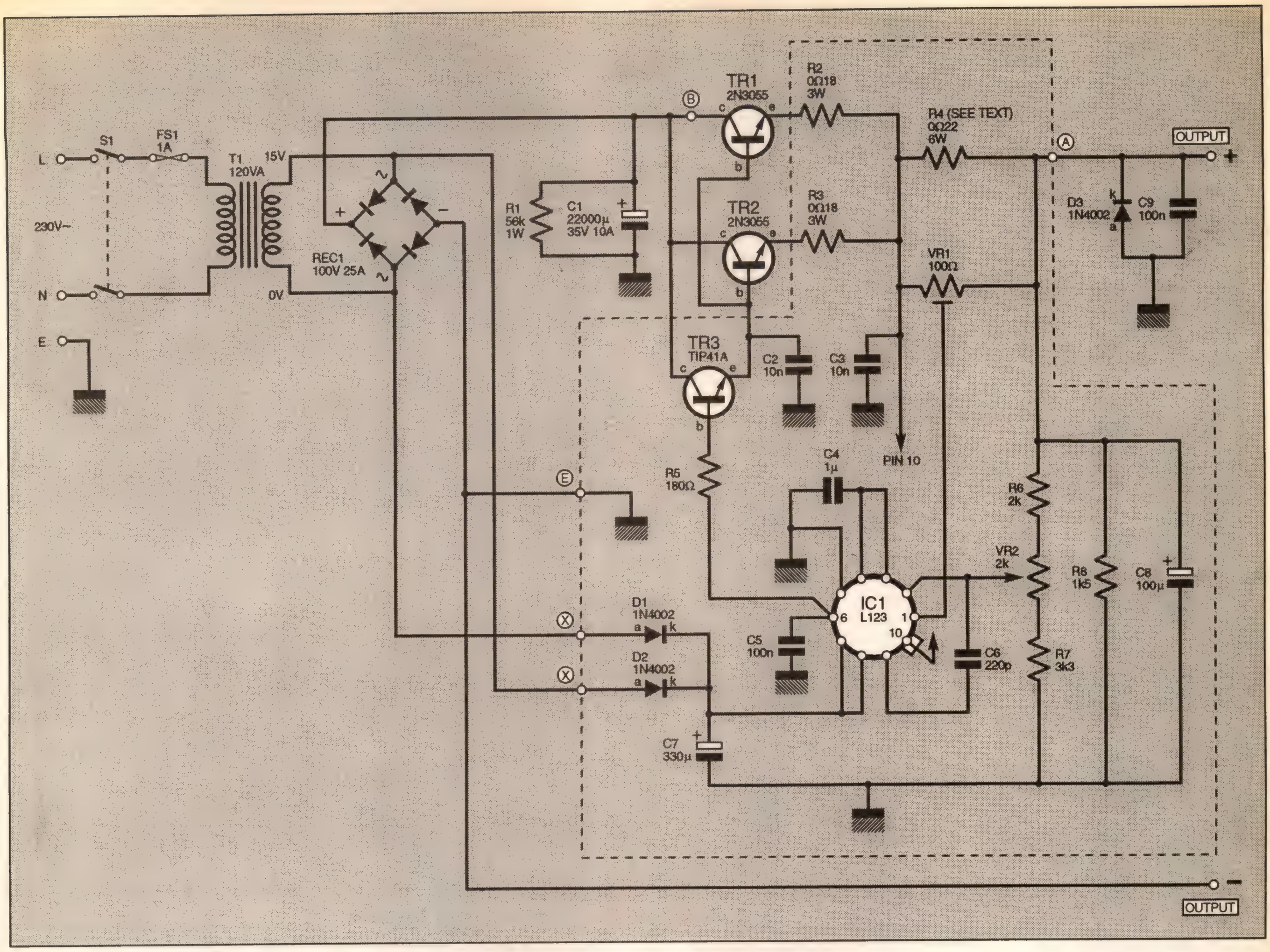


*Fig. 3. Complete circuit diagram for the High Current Stabilized Power Supply. The components inside the dashed area are all mounted on the p.c.b.*

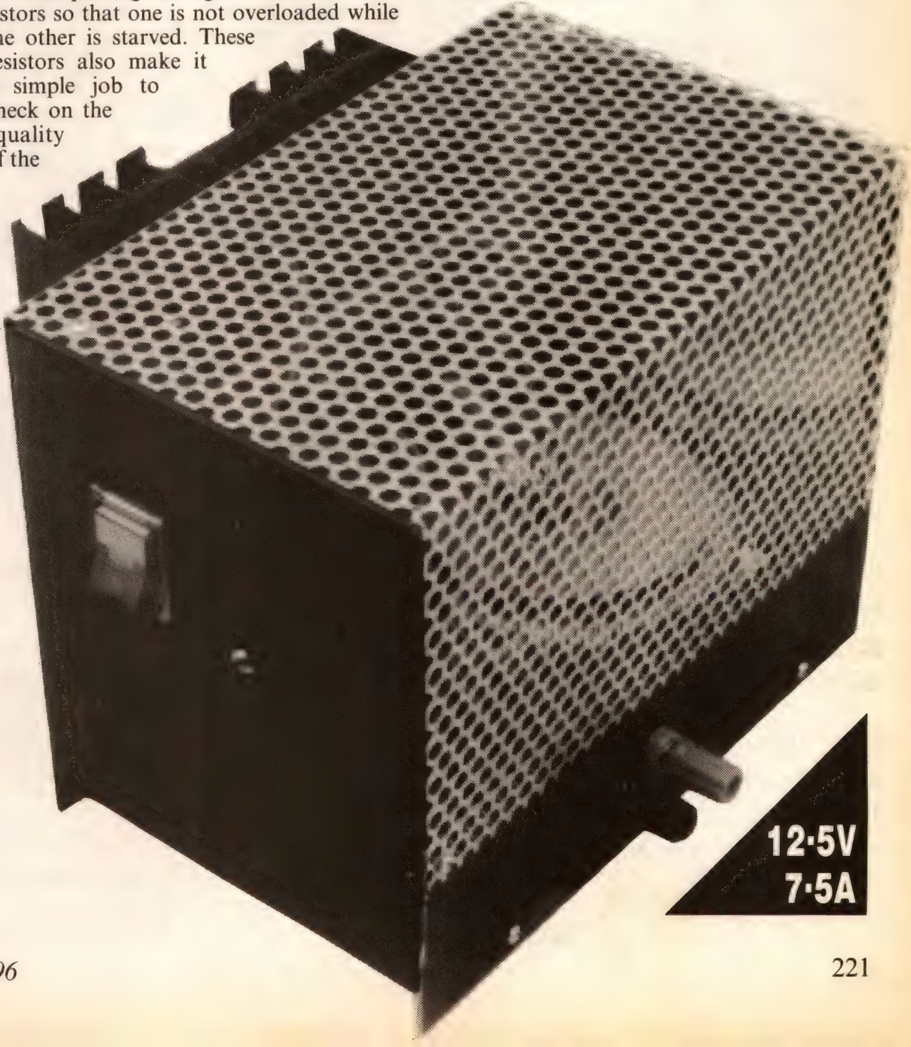
By connecting these pins across a sensing resistor *RS* in series with the positive output lead, transistor TRB is switched on when the voltage across *RS* exceeds about 0·65V, which is the nominal current sense operating voltage. By the right choice of resistance value, this voltage can be made to have its effect when the output current reaches a desired maximum level. Transistor TRB then conducts and a low resistance path is introduced across the base-emitter junction of TRA, so tending to cut its collector current off and reduce the output current to a safe maximum limit.

## EXTERNAL CONTROL

Since the maximum power dissipation of the L123 is only 800mW and this derates by about 7mW per degree Centigrade rise in temperature, the regulator on its own cannot provide the 7·5A design level for this power supply unit. The answer to this is to use the voltage regulator merely as a *current* drive to an external series control system which is capable of handling the high current required; the regulator will, of course, still provide the necessary stabilization of the output voltage.

The external control system is made up from three transistors, TR1 to TR3, as can be seen from the full circuit diagram of the High Current Stabilized Power Supply shown in Fig. 3. Transistors TR1 and TR2 are a pair of our old and trusted 2N3055's, being readily available and very cheap, connected in parallel to share the load current with their "commoned" bases driven in turn by TR3, a TIP41A fed from the regulator output pin.

Resistors R2 and R3 act to balance the currents passing through the control transistors so that one is not overloaded while the other is starved. These resistors also make it a simple job to check on the equality of the currents by measuring the voltage dropped across each of them.



## POWER SUPPLIES

The supply to the regulator board, within the dashed area, is taken separately from that feeding into the control transistors. The latter being derived from bridge rectifier REC1 and reservoir capacitor C1. These components along with the mains transformer T1 and the power transistors are, of course, separately mounted and hard wired away from the regulator board.

Capacitor C1 should have a minimum capacity of 22000μF and be of at least 10A ripple current rating. Resistor R1 is simply a "bleed" resistance which discharges C1 after switch off and is in no way critical in value.

The regulator section itself is effectively fed from a bi-phase arrangement of diodes D1 and D2, the transformer "centre tap" being created by the action of the bridge rectifier. Capacitor C7 smooths the regulator supply and need have no special qualities outside of an adequate voltage rating. Adjustment of preset VR2 varies the feedback voltage so that a precise level of output voltage can be set within the range already mentioned.

## VOLTAGE LIMITING

To make it possible to obtain the correct limiting voltage across the sense resistor R4, this component needs to be adjustable; since it is carrying a current up to a possible 7·5A, however, it must of necessity be of high wattage rating and a variable resistance is out of the question. However, by shunting it with a preset control (VR1) high enough in value relative to that of R4 (so making the current through this preset very small), a voltage can be tapped off which will operate the low current requirement of the limiting transistor inside IC1.

Taking the upper acceptable limit to be 9A with a short-circuited output, the voltage developed across R4 must, at that current level, reach the nominal 0·65V in order to operate the internal transistor. The required resistance value of R4 must then be 0·65/9 = 0·07Ω at a power rating of $9^2$ × 0·07 = 5·7W.

Such a value is unlikely to be found in an advertiser's list, so the resistance has to be made up from obtainable values. By placing two 0·22Ω, 6W resistors in parallel, a value of 0·11Ω at 12W is obtained; this will be adequate to produce a sufficient voltage at a current of 9A or so, and the proper point of this can be selected by adjustment of preset VR1.

There is little more to say about the circuit design; capacitor C9 and diode D3 are wired directly across the output terminals and these help to prevent any instability from arising. D3 also protects against reverse voltage pulses fed back from external circuits that may be highly inductive.

## CONSTRUCTION

The components to be mounted on the regulator printed circuit board (p.c.b.) are those shown within the dotted lines of Fig. 3. The full size copper foil master pattern and the topside component layout is given in Fig. 4, with an indication of the wiring to the external parts of the circuit. This board is available from the *EPE PCB Service*, code 979.

When assembling the board, the only awkward component is the 10-pin regulator IC1. If you undertake to make your own p.c.b., the holes for IC1 should be very carefully drilled through the appropriate pads with a 0·5mm drill, and when threading the ten wire connections through these, great care (and a bit of patience) has to be exercised.

It is essential to get the orientation of the regulator IC1 right *before* soldering it in place as it is practically impossible to remove the component afterwards without damaging it or the board. The small projection or tab on the base corresponds to pin 10; get this in the right hole and the rest will be automatically correct. Solder very carefully to avoid unwanted bridging, and space the metal can about 3mm to 5mm above the board surface.

The remainder of the components can now be fitted, noting the following particular points: Resistors R2, R3, and the two parallel resistors making up the

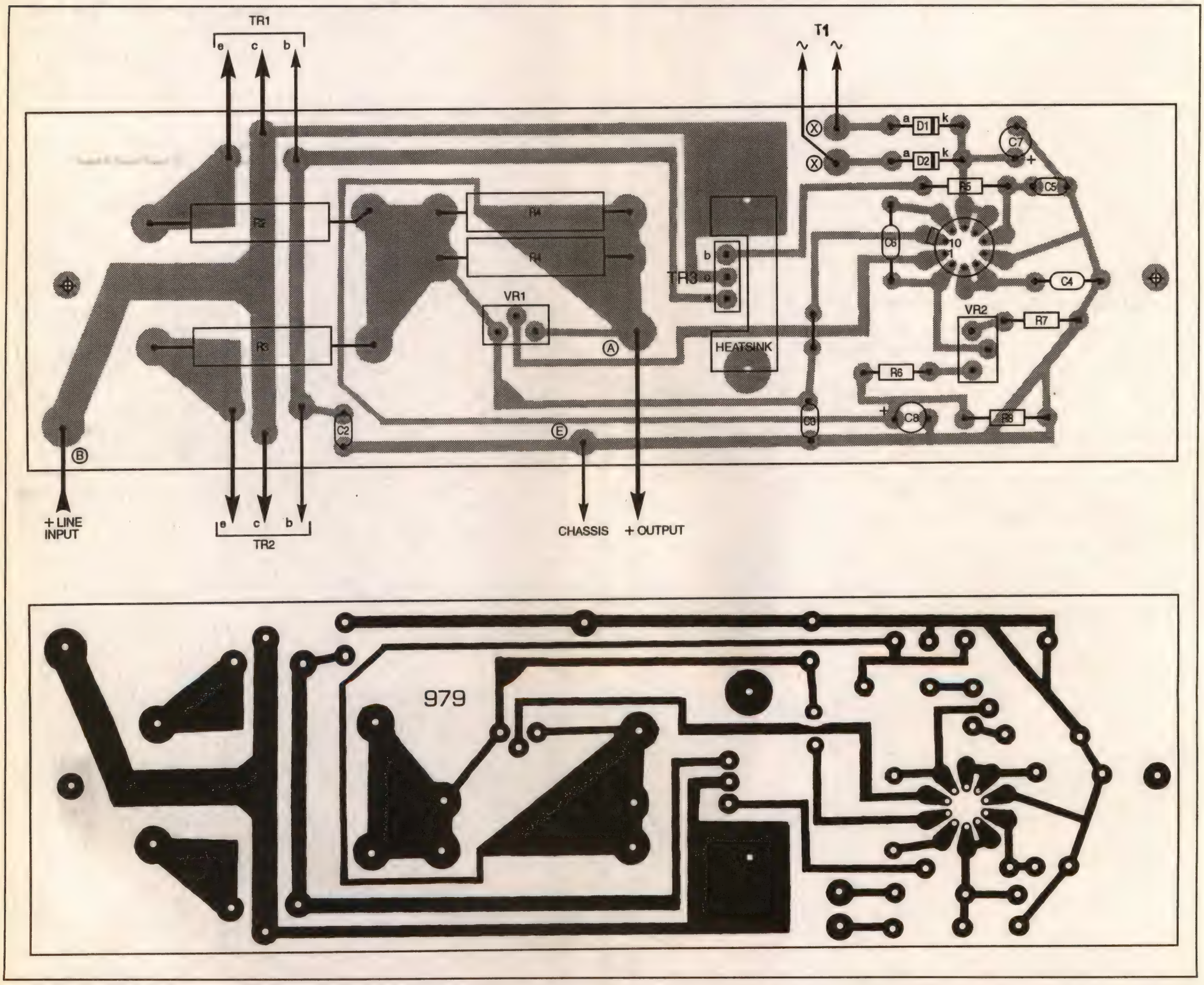


*Fig. 4. Power supply printed circuit board component layout and full size copper foil master pattern. Note that the high wattage resistors must be mounted clear of the p.c.b.*

"sense" resistor R4 should *NOT* be in contact with the board, space them at least 6mm above the board. Transistor TR3 is fitted to a small heatsink which is soldered to the board by two legs.

An alternative heatsink can be made from a piece of 18 s.w.g. aluminium bent to the dimensions shown in Fig. 5. Here actual fixing to the board can be ignored, the heatsink being supported directly by the transistor itself.

Make a note that trimmer potentiometer VR1 is of the horizontal mounting type; if a vertical type is used its adjustment will be fouled by the R4 resistors, unless you tilt it about 45 degrees so that screwdriver access to the adjusting screw is possible.

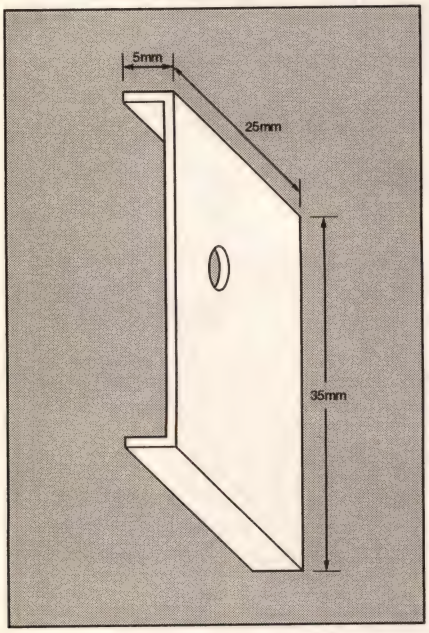


*Fig. 5. Dimensions for the 18 s.w.g. aluminium "homemade" heatsink for transistor TR3. The mounting hole is central and 5mm from one end.*

## MAIN HEATSINK

The main heat sinking for the two pass transistors, TR1-TR2, has to be substantial as something of the order of 100W is delivered by the unit at its maximum output. The heatsink used here has a thermal rating of 1·25°C/W and any alternative used (or fabricated) should be *at least* of this rating. By buying an un-anodised version of this heatsink (that is, a plain aluminium finish), the cost is almost halved from that of a ready anodised type, and it is not a lot of trouble to spray this cheaper version either with matt or satin black car primer type paint.

Fixing of the heatsink is carried out using four captive nuts which can be slid into position on the rear of the 'sink, and these will be used later on in the construction. First of all, holes have to be drilled (if this is not already done) for the two 2N3055 pass transistors, see Fig. 6a; these are TO3 mountings and an insulating washer can be used here as a template.

Drill these holes accurately and (for the actual fixing holes) of the correct size to suit the insulating washers and bushes supplied for the 2N3055's. Ensure that the holes are thoroughly de-burred or you will have trouble with the insulation when you carry out the mounting procedure as illustrated in Fig. 6.

If mica washers are used, they should be given a smear of heat conductive compound on each side. The alternative silicone rubber washers do not need this and this sort give a better heat transfer than mica types.

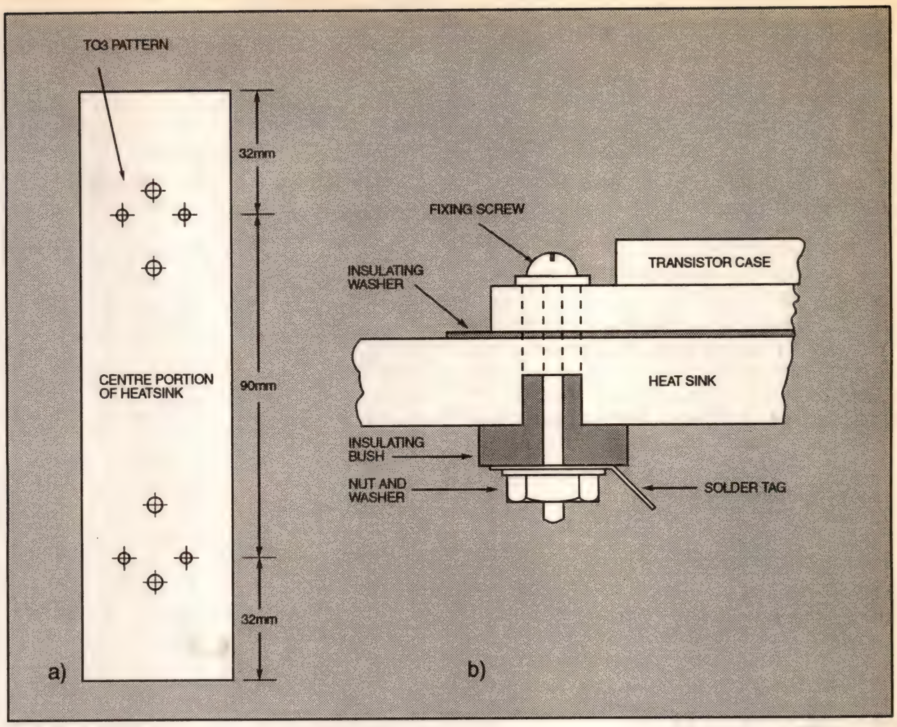


*Fig. 6. The main heatsink drilling and mounting details for the power transistors TR1 and TR2. Note that the transistor body is also its collector contact.*

Put a solder tag under one each of the transistor fixing nuts for making a later connection to the collectors (c) as Fig. 6 shows. When completed, check carefully that the collectors (the cases) are *insulated* from the heatsink and that the base (b) and emitter (e) pins are clear of any contact with the heatsink holes through which they pass.

You will need room to solder a fairly heavy-duty flexible lead to the emitter pins later on, so make sure you will have enough clearance for this stage. It is essential, however, that you do not make these pin holes excessively large or a large area of thermal contact with the heatsink will be lost; a 5mm hole should be considered a maximum size.

## MAIN CHASSIS

It may happen that you have a metal case which will serve well enough for this project, preferably aluminium. If so, the side on which the heatsink will be mounted should be at least 165mm (6½ins) high by 203mm (8ins) wide. The depth will be adequate at a minimum of 130mm (5ins).

*Completed PSU showing the mounting of the main heatsink and pass transistors.*

For simplicity of assembling the project, however, it is as well to make up your own case, and this can be done by initially bending a piece of 18 s.w.g. aluminium measuring 347mm (13¾ins) by 205mm (8ins) approx. to the form shown in Fig. 7. The large vertical side of this then carries the heatsink and, on its inside face, the p.c.b.

The other large components then occupy the floor or base, with the output terminals on the smaller rear panel. Two sides are fitted later, one of which will carry the mains input socket and the mains switch.

The holes to be made in the base of this chassis are not shown in the diagram as their exact positions will depend upon the components used; the mountings and physical sizes can vary slightly between manufacturers. The fixing holes are therefore best left until the components are to hand. We will return to this later.

At this stage it is a good plan to get the heatsink mounted on the vertical side of the chassis. This means aligning it so that it is central on the aluminium face and that the two 12·5mm (½in.) holes coincide with the transistor positions already drilled on the heatsink. The collector, base and emitter wires can then in due course be brought through the holes for connection to the appropriate solder pins on the p.c.b.

The holes for securing the heatsink itself to the panel have to suit the positions set for the captive nuts and some care is required to ensure the coincidence of the holes and nuts. The best way here is to slide the nuts along their channels so that they are set in line with the mid-point of the transistor drilling groups at each end. The four fixing hole positions can then be fairly easily marked and drilled on the panel so that alignment is secured.

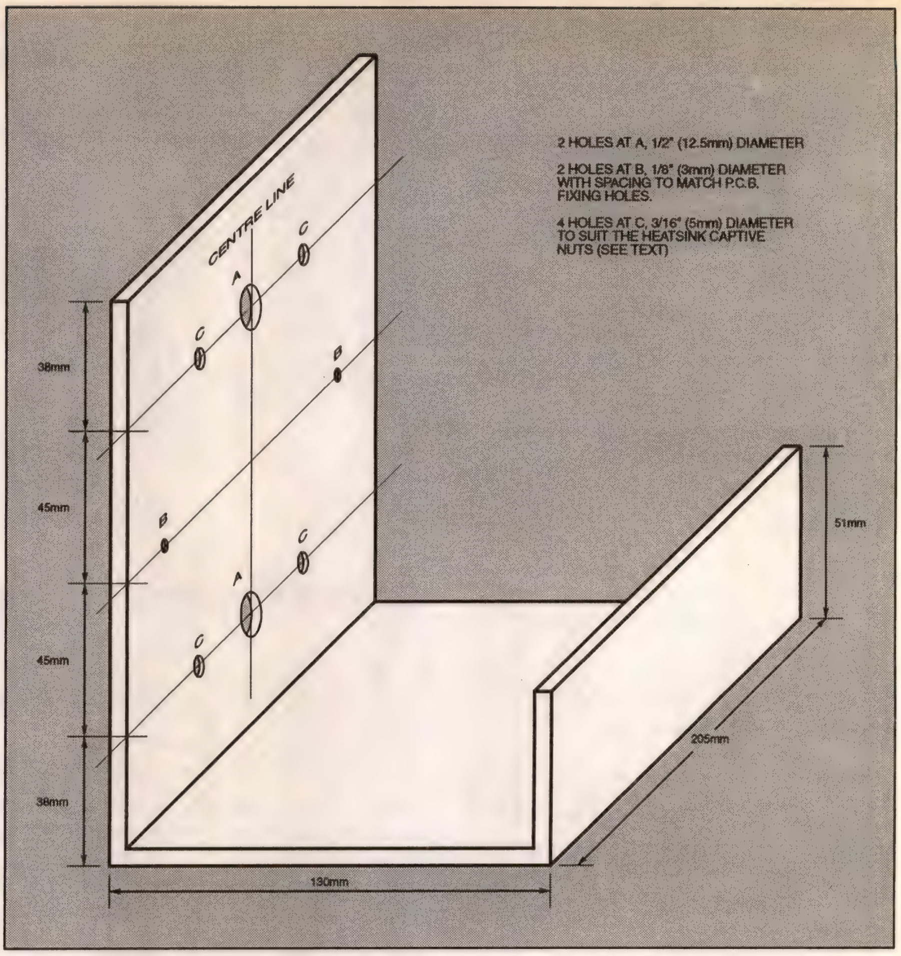
This arrangement of the holes is illustrated in Fig. 7, though you can, of course, do you own thing if you have other (and perhaps better) ideas of how to cope with the alignment. Using 4BA screws, now temporarily fit the heatsink to the panel as a general check on the positioning.

## TOROIDAL TRANSFORMER

There is nothing particular to say about the bridge rectifier REC1 or the reservoir capacitor C1, but a note is called for about the toroidal transformer. This component is easily fitted to the floor of the chassis by a single central bolt which is supplied with the transformer, along with a dished metal washer and two protecting pads. Make sure when mounting this component that these pads are fitted above and below the windings so that the dished washer is on top of the upper pad.

To make things neat and tidy and to avoid having to manipulate heavy gauge wiring around the assembly, the dished washer should have a strong 3-way tag strip (or a heavy-duty 2-way "chocolate block" may be used) bolted to it so that the secondary wires can be terminated close to the transformer itself; there are two secondary windings which are paralleled, and the connections to be made for this are supplied with the transformer. It is important when fitting the tag strip that the screw used is countersunk so that there is no projecting head pressing on to the upper pad when the washer is screwed down.

***Under no circumstances must the dished washer be electrically connected to the chassis, or the central screw will act as a short-circuited turn and damage the transformer.***



2 HOLES AT A, 1/2" (12.5mm) DIAMETER

2 HOLES AT B, 1/8" (3mm) DIAMETER WITH SPACING TO MATCH P.C.B. FIXING HOLES.

4 HOLES AT C, 3/16" (5mm) DIAMETER TO SUIT THE HEATSINK CAPTIVE NUTS (SEE TEXT)

*Fig. 7. General details of the main chassis. Side fixing holes and rear output terminal holes are not shown as this depends on components used.*

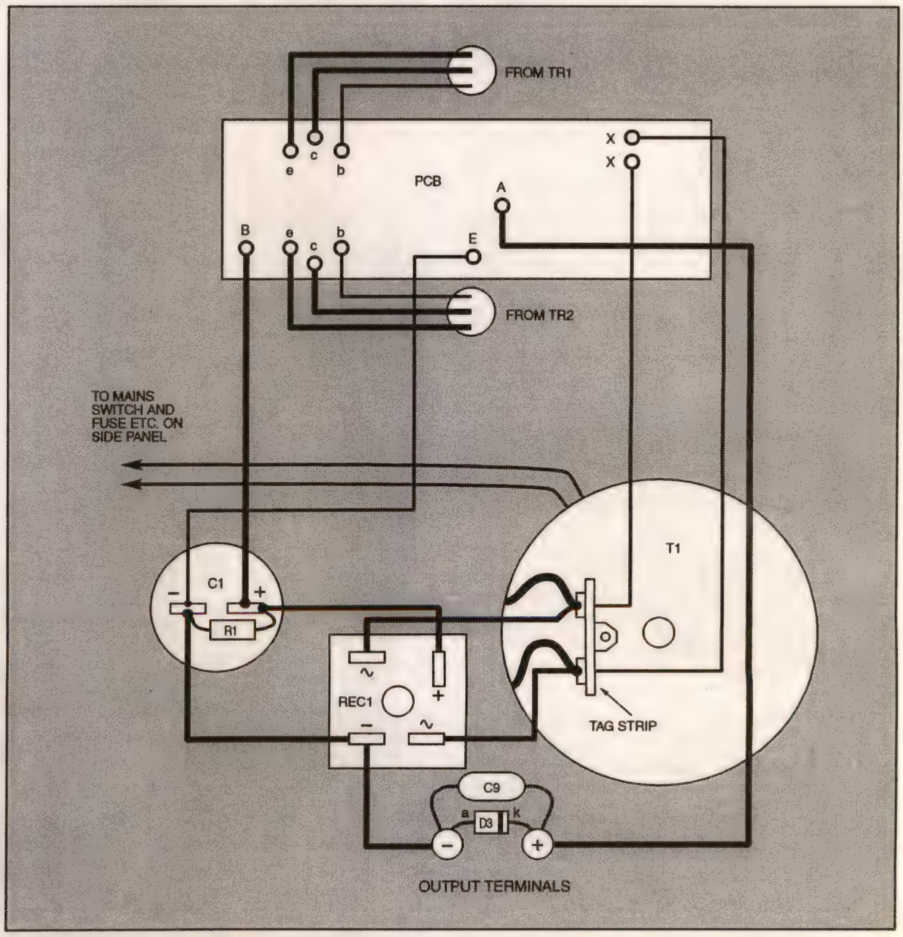


*Fig. 8. Mounting positions of the "floor" components and interwiring. The heavy duty wires are shown as thicker leads. The two secondary windings of the transformer are paralleled together and their leads soldered to the tag strip.*

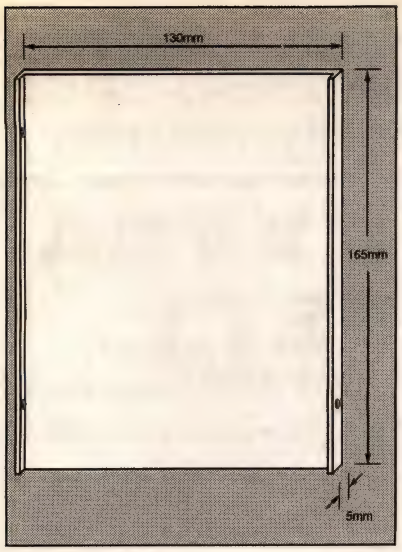


*Fig. 9. Overall side panel details. Actual measurements depend on main chassis size..*

## OVERALL ASSEMBLY

Having completed the preliminary stages of construction detailed above, the overall assembly and wiring of this power supply is fairly straightforward. First of all, solder the collector, base and emitter leads to the pass transistors TR1 and TR2. These leads should at this stage be cut to about 100mm (4ins) in length, and for the collector and emitter, heavier gauge wires are needed.

Flexible 24/0·2 PTFE insulated wire should be considered as a minimum gauge; the base lead may, however, need be only 7/0·2 or similar. Use different colours so that there is no confusion when these wires are routed from the heatsink to the p.c.b. and check again *after* you have completed the soldering that there is no electrical contact between any of the leads and the heatsink.

Bolt the heatsink on to the chassis (which should have its main panel sprayed matt black on both sides), threading the connecting wires through their respective holes. Make sure that the leads come cleanly through the holes and do not get crumpled up between the heatsink and the chassis.

Now mount the printed circuit board to the rear of the panel, spacing it off by about 12·5mm (½in) with suitable spacers or nuts. Solder the leads from TR1 and TR2 transistors to the appropriate solder pins on the board, shortening them as necessary as you proceed but without pulling them tight in any way.

The remainder of the wiring can now follow the pattern shown in Fig. 8 which shows a flattened view of the assembly. Only those leads shown in the *heavy* lines need be of substantial gauge.

## ON THE FLOOR

The floor mounted components (toroidal transformer, reservoir capacitor and bridge rectifier) are not particularly critical in their positions and for this reason no dimensions have been shown. Simply ensure that there is no fouling with other parts, then drill single fixing holes for the transformer and bridge, and two holes for capacitor C1 to suit the clip into which it will be mounted. The paralleled pairs of the secondary transformer windings are perhaps best shortened, thoroughly cleaned of enamel and soldered to the tag strip before mounting the component.

## COMPONENTS

Approx cost guidance only **£55**

**Resistors**

| | |
|---|---|
| R1 | 56k 1W |
| R2, R3 | 0·18Ω 3W wirewound (2 off) |
| R4 | 0·22Ω 6W wirewound (2 off) – see text |
| R5 | 180Ω |
| R6 | 2k |
| R7 | 3k3 |
| R8 | 1k5 |

All 0·25W carbon film, except where stated

**See SHOP TALK Page**

**Potentiometers**

| | |
|---|---|
| VR1 | 100Ω enclosed, top adjust, carbon preset |
| VR2 | 2k enclosed, side adjust, carbon preset |

**Capacitors**

| | |
|---|---|
| C1 | 22,000µ radial elect. 35V, 10A ripple rating |
| C2, C3 | 10n min. polycarb. 63V (2 off) |
| C4 | 1µ polyester layer, 63V |
| C5, C9 | 100n poly. layer, 100V (2 off) |
| C6 | 220p ceramic |
| C7 | 330µ radial elect. 35V |
| C8 | 100µ radial elect. 35V |

Working voltages are minimum values

**Semiconductors**

| | |
|---|---|
| D1, D2, D3 | 1N4002 100V 1A rectifier diode (3 off) |
| TR1, TR2 | 2N3055 power transistors (2 off) |
| TR3 | TIP41A power transistor |
| IC1 | L123 voltage regulator, TO100 base |
| REC1 | 100V 25A bridge rectifier |

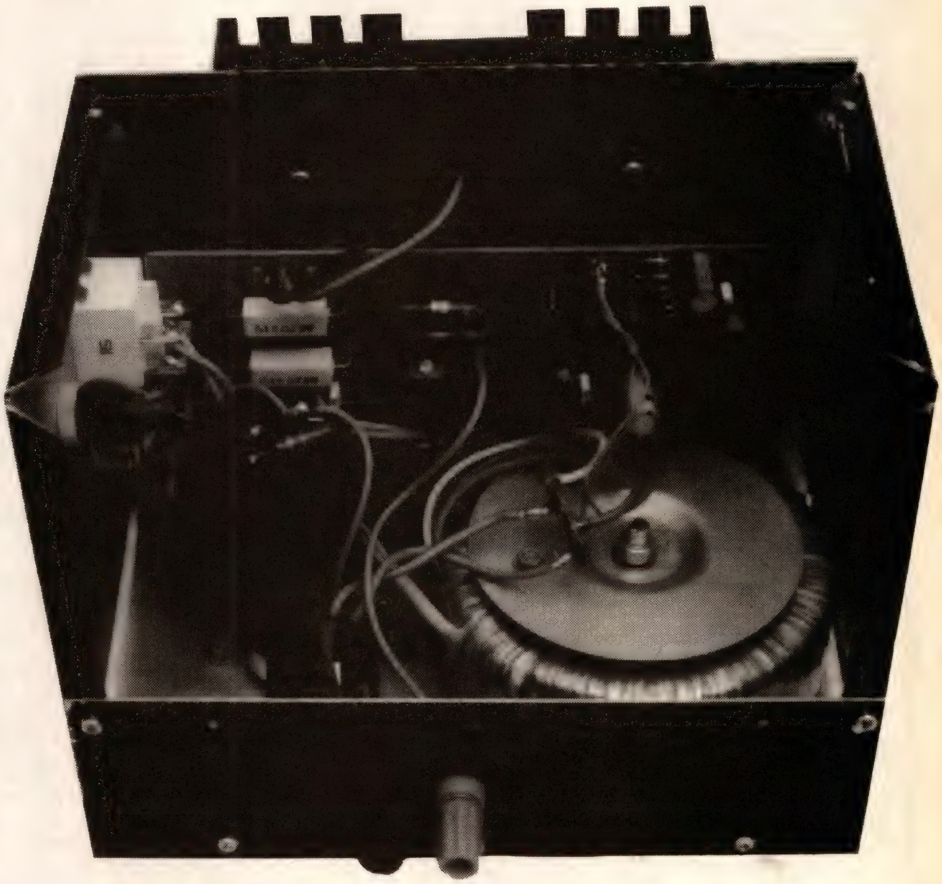
**Miscellaneous**

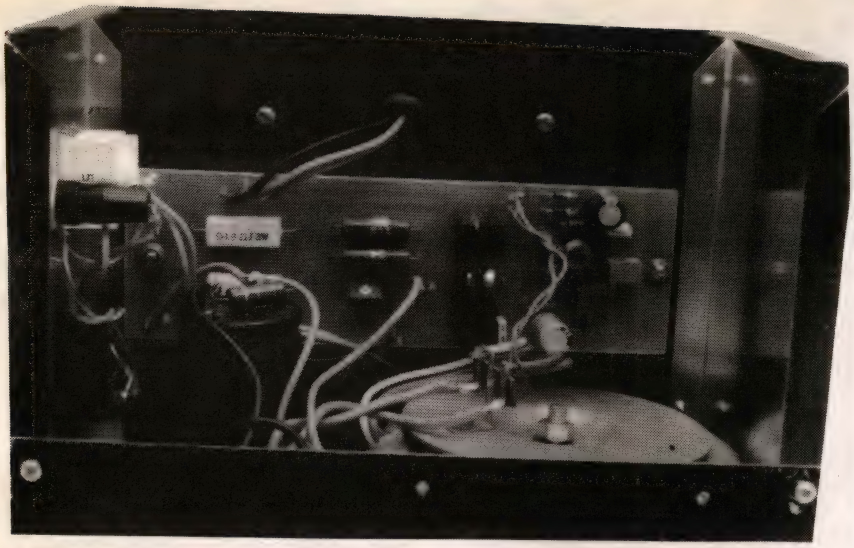
| | |
|---|---|
| T1 | Toroidal transformer 120VA, 15V + 15V secondaries |
| S1 | Double-pole on-off 250V toggle switch, or with indicator |
| FS1 | Fuseholder, panel mounting, with 1A cartridge fuse |
| SK1 | 3-pin, chassis mounting, Bulgin plug with line socket |
| SK2, SK3 | Red and black, chassis mounting, screw terminals |

Printed circuit board available from *EPE PCB Service*, code 979; 18 s.w.g. aluminium sheet, for main chassis, size 347mm x 205mm approx.; aluminium side panels, size to choice – see text; ribbed 1·2W/°C (unanodised) heatsink, size 152mm x 130mm; small TO220 heatsink, 12·5mm p.c.b. spacers, 2 off; stick-on rubber feet, 4 off; fixing nuts and bolts; multistrand connecting wire, gauge to suit – see text; solder pins; solder etc.

Connections to the bridge rectifier REC1 (and possibly to the large electrolytic capacitor) are best made using crimped push-on type connectors, though if your crimping may be suspect, these can be soldered to the leads. It is *not* good practice to solder directly to the bridge rectifier tabs.

The primary leads from the transformer are taken directly to the side panel (to be described) where the mains input socket, switch and fuseholder are fitted. Either side panel may be used for this purpose; just ensure that none of these side components will foul the internal parts when the side panel is fitted.





*The completed p.c.b. bolted in position on the main chassis. Note the rubber grommet protecting the leads from the power transistors.*

## SIDE PANELS

Two side panels need to be fitted to the main chassis piece of Fig. 7 and these should be made to the pattern shown in Fig. 9. They should be bent to fit snugly into each side of the chassis and secured with self-tapping screws to suit holes in the front and rear panels. You will probably find that you have to adjust the given dimensions slightly, depending upon actual dimensions of the first chassis.

When these sides have been fitted, the unit will be secured in a box with a low back panel and an open top. The final boxing-in should not be done with solid aluminium sheet but to help with ventilation should be covered with some perforated material, steel or aluminium, bent to the shape as seen in the photograph(s) of the completed unit. This again is secured with a few self-tapping screws.

One of the side panels (you can make your own choice here) is drilled to accommodate the mains switch S1, fuseholder FS1 and (if required) a neon indicator. In the prototype an illuminated switch was used with a panel mounting fuseholder.

An ordinary double-pole toggle switch may be used instead, with a separate indicator, and the mains lead may be brought out through a suitably grommeted hole instead of using a 3-way mains input socket as in the prototype. This part of the construction is simply a matter of positioning whatever parts you have so that there is no fouling with other parts when the panel is fitted, and consequently the drilling pattern is a matter of your own choosing and convenience.

## SETTING UP

There is little to do in the way of checking and setting up the project. Start with both preset potentiometers VR1 and VR2 set to their mid-positions and connect a voltmeter across the output terminals.

On switching on, the voltmeter should give an indication of the output voltage and be capable of adjustment through a limited range (about 11V to 16V) by preset VR2; set the output to 13·8V if this is the level you require, or whatever you might need within the available range.

Adjustment of preset VR1 must be made so that the output current for a short-circuit load condition does not exceed about 8A. The output characteristic is flat within about 0·2V over the range 0 to 7A, but *must* begin to *fall rapidly* after this level as the load increases, thus restricting the output current to about 8A under shorted conditions.

It is a bit difficult to check on the stability of the output over the current range without a fairly massive adjustable resistance to act as the load (a 15ohm slide type potentiometer capable of carrying 10A just happened to be to hand). But you can check the stabilization of the output voltage at a few current levels by using, say, 6W or 10W resistors of value 6·8Ω, 3·3Ω, and 2·2Ω, having them switched on *only* long enough for you to take the voltage reading. If the voltage remains within about 0·2V of your initial setting, there should be no problems with the stabilization.

It may happen that at a lower current, the voltage drops; this indicates that VR1 needs setting accurately, as the current limiting is coming on too soon. In this case, the setting of VR1 should be slightly increased with a clockwise rotation until the drop vanishes.

The easiest way of setting preset VR1 is to connect an ammeter capable of reading up to 10A (which most digital types will do) directly across the output terminals; this then acts as a virtual short-circuit. Switch on and adjust VR1 to give a reading of 8A on the meter. *Do not to take an excessive time over this check.* The unit should then be correctly set up.

## CHECK POINTS

There are one or two measurements you can make around the circuit to provide a general purpose look at the unit's operation. The voltage across capacitor C1 should be about 23V to 24V when drawing a current of about 5A; this voltage will vary slightly with the actual load, but should not change by any significant amount.

The voltages across resistors R2 and R3 should be approximately equal; any serious difference will indicate that one of the pass transistors is not doing its stuff, and an investigation should be made.

Make sure, also, that the heatsink has clearance from any heated surfaces such as radiators and that the air flow around it is unrestricted.

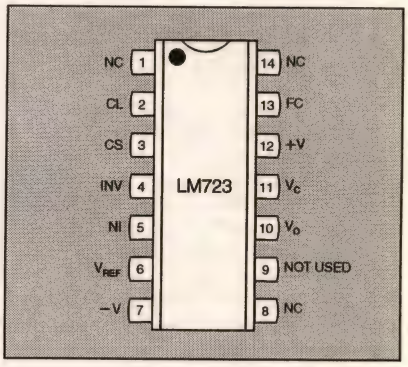


*Fig. 10. Pinout details for the LM723 14-pin d.i.l. alternative regulator. If this device is used the p.c.b. will need altering.*

## ALTERNATIVE REGULATOR

For those who like to design and make their own boards, the TO100 based L123 can be replaced by the LM723 14-pin d.i.l. version.

There are three "no-connection" pins on this version, but the other pins are equivalents to the pins on the L123, though pin 9 is ignored. The pin connections for this regulator are given in Fig. 10. ☐

EVERYDAY
PRACTICAL
ELECTRONICS
SUBSCRIPTION ORDER FORM
Annual subscription rates (1996): UK £24.00.
Overseas £30 (surface mail) £47.50 (airmail)
To: Everyday Practical Electronics,
Allen House, East Borough, Wimborne, Dorset BH21 1PF
Tel: 01202 881749 Fax: 01202 841692

I enclose payment of £ ............ (cheque/PO in £ sterling only),
payable to Everyday Practical Electronics
Access or Visa No.
VISA
☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Signature..........................................................................

Card Ex. Date ...................................................................

Please supply name and address of cardholder if different from the subscription address shown below. **Subscriptions can only start with the next available issue.** For back numbers see the Editorial page.

Name ...............................................................................

Address ...........................................................................

.........................................................................................

..................................................... Post code.................................... 3/96

MAKE SURE YOU GET YOUR *EPE*

# THE ELECTRONICS SERVICE MANUAL

### ESM ESM IS ABOUT ELECTRONICS AND ELECTRONIC EQUIPMENT, EXPLAINING:

• What it is • How it works • How to test it • How to take it apart
• How to find faults • How to fix it

### OFFERING:

• Down to earth advice • Vital data • Facts to feast on
• Knowledge at your finger-tips

### T TOPICS COVERED:

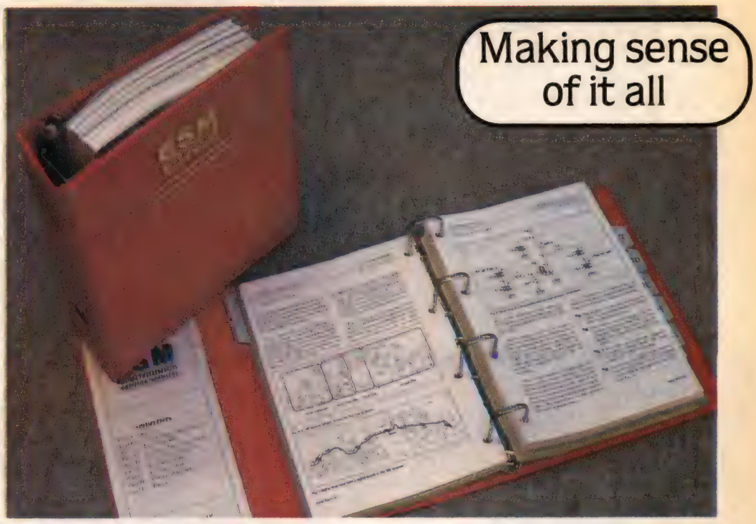
• TV • Audio • Video • Computers • Disk drives • Techniques
• Test gear • Workshops • Addresses • Pinouts • Symbols • Safety
• Logos • Tools • Data • etc

### W WHO IT'S FOR:

• Across the board appeal !
• Ideal for: Technicians • Engineers • Students • Hobbyists

### L LITERARY MERIT:

• Authoritatively written • Clearly presented • Highly readable
• A living library in words, drawings and photographs



### S SUPPLEMENTS

Detailed technical servicing notes on various types of equipment are covered in the quarterly Supplements, plus additional valuable information for other sections of the Manual

### F FREE

We will send you the latest Supplement FREE with your Manual

### P PRICES

Manual only £39.95 plus P&P

Over 850 A4 pages edited by Mike Tooley. Supplied in robust ring binder. Latest Supplement included FREE. 24-hour despatch

Supplements £23.50 plus P&P

Approximately 160 pages of facts and data in each Supplement

### G GUARANTEE

Our NO-QUIBBLE MONEY-BACK GUARANTEE gives you *complete peace of mind*. If you are not entirely happy with the Manual or its Supplements, for whatever reason, simply return to us in good condition (within 30 days for the Manual, 10 days for Supplements) and we will make a FULL REFUND of your payment. (Overseas buyers do have to pay the postage charge.)

### H HOW TO OBTAIN ESM

Order now! – just fill in the order form.
Or, to find out more about ESM, ring, fax or write to:

Wimborne Publishing Ltd, Dept Y3
Allen House, East Borough, Wimborne
Dorset BH21 1PF
Tel: 01202 881749 Fax: 01202 841692

## ELECTRONICS SERVICE MANUAL COVERAGE AND CONTENTS

### SAFETY A

Safety practices, life-saving techniques, legal requirements

### UNDERPINNING KNOWLEDGE B

Electronics theory, component theory & functions, circuit techniques, fault diagnosis, detailed equipment principles

### PRACTICAL SKILLS C

Component identification, avoiding static, soldering & component replacement techniques

### TOOLS AND EQUIPMENT D

Choosing tools & test gear, workshop practice, optimising test equipment

### SERVICING TECHNIQUES E

The Supplements include detailed guidelines on how to service specific types of electronic equipment

### TECHNICAL NOTES F

Detailed examination of how specific types of electronic equipment work

### REFERENCE DATA G

Detailed tables of specifications for semiconductors, including pinouts

### USEFUL ADDRESSES H

Manufacturers' & suppliers' addresses, including logos

### INDEX I

Itemised key subjects in the Manual and individual Supplements

## PRIORITY ORDER FORM

Full name:......................................................................................
(BLOCK CAPITALS PLEASE):
Address: ......................................................................................
......................................................................................
..................................................Post code:......................................
Telephone Number: ......................................................................................

☐ I enclose cheque/PO payable to WIMBORNE PUBLISHING LTD
☐ Please charge my Access (Mastercard)/Visa card. Expiry date..........................

Card No: ......................................................................................
*(Please advise cardholder's address if different from above)*

Please send me each new quarterly Supplement when it is published. I understand that these are billed separately and that they can be returned within 10 days or discontinued at any time.

I understand that should I decide not to keep the Manual I can return it to you within 30 days for a FULL REFUND (overseas customers must pay the postage).

Signature: ......................................................................................

### PLEASE URGENTLY SEND ME

| *Item* | *Cost* | *Postage* | *Total* |
|---|---|---|---|
| ESM Manual | £39.95 | £ | £ |
| One Supplement free with Manual | FREE | FREE | £0.00 |
| Payment in £ Sterling only | | Total | £ |

### POSTAGE CHARGES

*Manual*

| *Postal Region* | *Surface* | *Air* |
|---|---|---|
| UK | £5.50 | – |
| Eire | – | £11 |
| Europe (EEC) | – | £20 |
| Europe (Non-EEC) | £20 | £26 |
| USA & Canada | £25 | £32 |
| Far East & Australia | £31 | £33 |
| Rest of World | £25 | £44 |

*NOTE: Surface mail can take over 10 weeks to some parts of the world. Each Manual weighs about 4kg when packed.*

Please send this form (or a copy) to: **Wimborne Publishing Ltd, Dept. Y3, Allen House, East Borough, Wimborne, Dorset BH21 1PF**

# VIDEOS ON ELECTRONICS

*A range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.*

**VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.**

**VT201** 54 minutes. Part One; **D.C. Circuits.** This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more. **Order Code VT201**

**VT202** 62 minutes. Part Two; **A.C. Circuits.** This is your next step in understanding the basics of electronics. You will learn about how coils, transformers, capacitors, etc are used in common circuits. **Order Code VT202**

**VT203** 57 minutes. Part Three; **Semiconductors.** Gives you an exciting look into the world of semiconductors. With basic semiconductor theory. Plus 15 different semiconductor devices explained. **Order Code VT203**

**VT204** 56 minutes. Part Four; **Power Supplies.** Guides you step-by-step through different sections of a power supply. **Order Code VT204**

**VT205** 57 minutes. Part Five; **Amplifiers.** Shows you how amplifiers work as you have never seen them before. Class A, class B, class C, op.amps. etc. **Order Code VT205**

**VT206** 54 minutes. Part Six; **Oscillators.** Oscillators are found in both linear and digital circuits. Gives a good basic background in oscillator circuits. **Order Code VT206**

By the time you have completed VT206 you have completed the basic electronics course and should have a good understanding of the operation of basic circuit elements.

## VCR MAINTENANCE

**VT102** 84 minutes: Introduction to VCR Repair. Warning, not for the beginner. Through the use of block diagrams this video will take you through the various circuits found in the NTSC VHS system. You will follow the signal from the input to the audio/video heads then from the heads back to the output. **Order Code VT102**

**VT103** 35 minutes: A step-by-step easy to follow procedure for professionally cleaning the tape path and replacing many of the belts in most VHS VCR's. The viewer will also become familiar with the various parts found in the tape path. **Order Code VT103**

Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier.

(All videos are to the UK PAL standard on VHS tapes)

**Now for the digital series of six videos. This series is designed to provide a good grounding in digital and computer technology.**

**VT301** 54 minutes. Digital One; **Gates** begins with the basics as you learn about seven of the most common gates which are used in almost every digital circuit, plus Binary notation. **Order Code VT301**

**VT302** 55 minutes. Digital Two; **Flip Flops** will further enhance your knowledge of digital basics. You will learn about Octal and Hexadecimal notation groups, flip-flops, counters, etc. **Order Code VT302**

**VT303** 54 minutes. Digital Three; **Registers and Displays** is your next step in obtaining a solid understanding of the basic circuits found in todays digital designs. Gets into multiplexers, registers, display devices, etc. **Order Code VT303**

**VT304** 59 minutes. Digital Four; **DAC and ADC** shows you how the computer is able to communicate with the real world. You will learn about digital-to-analogue and analogue-to-digital converter circuits. **Order Code VT304**

**VT305** 56 minutes. Digital Five; **Memory Devices** introduces you to the technology used in many of todays memory devices. You will learn all about ROM devices and then proceed into PROM, EPROM, EEPROM, SRAM, DRAM, and MBM devices. **Order Code VT305**

**VT306** 56 minutes. Digital Six; **The CPU** gives you a thorough understanding in the basics of the central processing unit and the input/output circuits used to make the system work. **Order Code VT306**

By now you should have a good understanding of computer technology and what makes computers work. This series is also invaluable to the computer technician to understand the basics and thus aid troubleshooting.

---

**VT401** 61 minutes. **A.M. Radio Theory.** The most complete video ever produced on a.m. radio. Begins with the basics of a.m. transmission and proceeds to the five major stages of a.m. reception. Learn how the signal is detected, converted and reproduced. Also covers the Motorola C-QUAM a.m. stereo system. **Order Code VT401**

**VT402** 58 minutes. **F.M. Radio Part 1.** F.M. basics including the functional blocks of a receiver. Plus r.f. amplifier, mixer oscillator, i.f. amplifier, limiter and f.m. decoder stages of a typical f.m. receiver. **Order Code VT402**

**VT403** 58 minutes. **F.M. Radio Part 2.** A continuation of f.m. technology from Part 1. Begins with the detector stage output, proceeds to the 19kHz amplifier, frequency doubler, stereo demultiplexer and audio amplifier stages. Also covers RDS digital data encoding and decoding. **Order Code VT403**

**VT501** 58 minutes. **Fibre Optics.** From the fundamentals of fibre optic technology through cable manufacture to connectors, transmitters and receivers. **Order Code VT501**

**ORDERING:** Add **£1.50 p&p** *per order* for UK orders. **OVERSEAS ORDERS:** Add £3 postage for countries in the EEC. Overseas orders outside the EEC countries add £3 *per tape* airmail postage (or £6 *per order* surface mail postage). All payments in £ sterling only (send cheque or money order drawn on a UK bank).

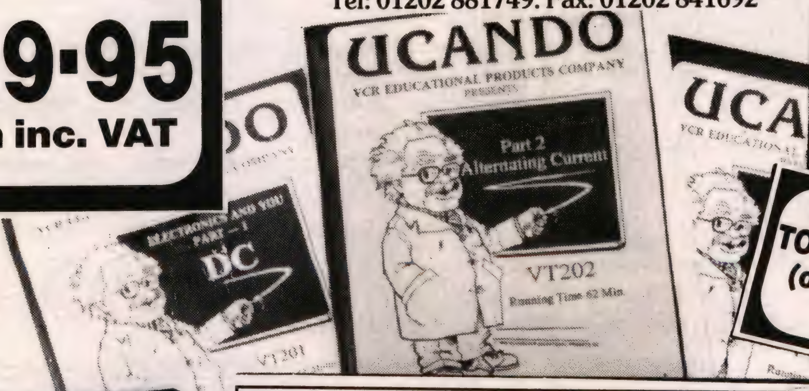
**Visa** and **Mastercard** orders accepted – please give card number, card expiry date and cardholder's address if different from the delivery address.

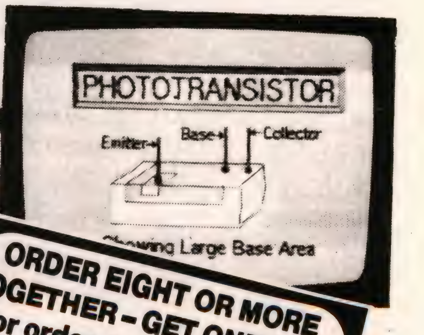
Orders are normally sent within seven days but please allow a maximum of 28 days – longer for overseas orders.

**Send your order to: Direct Book Service, 33 Gravel Hill, Merley, Wimborne, Dorset BH21 1RW (Mail Order Only)**

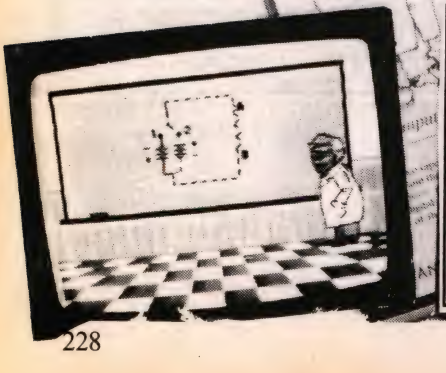
Direct Book Service is a division of
Wimborne Publishing Ltd.,
Tel: 01202 881749. Fax: 01202 841692

**£29·95**
**each inc. VAT**





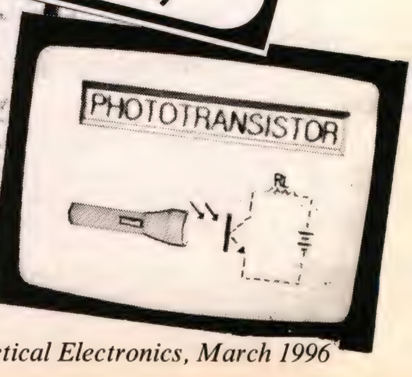
**ORDER EIGHT OR MORE TOGETHER – GET ONE FREE (or order 16 together and get TWO FREE)**



## ★★★ NEW ★★★

### VT502 LASER TECHNOLOGY

The latest release from UCANDO is a 57 minute video on **Laser Technology.** The video is divided into five sections each looking at a different type of laser. Following a basic introduction covering some of the common uses of laser devices, the video proceeds to cover the operation of the Ruby Rod laser, HeNe laser, $CO_2$ gas laser and semiconductor laser devices. It also covers the basics of CD and bar code scanning.



....ANOTHER GREAT IDEA FROM MINICRAFT....

# MIRACLE POINT HAND TOOLS

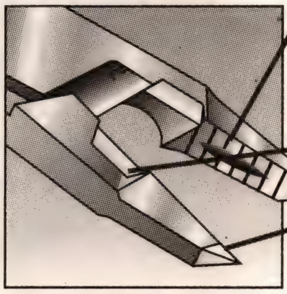
## Precision Hand Sharpened Stainless Steel for all Fine Work

A new great value range of stainless steel hand tools ideal for high accuracy work. The entire Miracle Point range is hand sharpened for maximum precision.

***THE RANGE CONSISTS OF:***

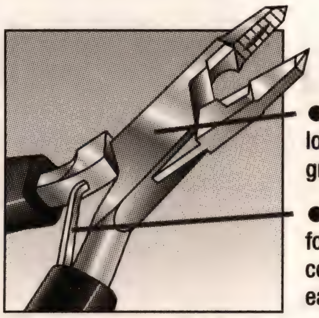
- **NEEDLE NOSE PLIERS** Box jointed for longer life.
- **BENT NOSE PLIERS** Box jointed. Ideal for working in confined areas.
- **MAGNIFIER TWEEZERS** With 5x power magnification for clear view of fine work
- **PRECISION TWEEZER** Supersharp point for all fine work.

*The Miracle Point range is ideal for anyone interested in hobbies, modelling, electronics and even general household repairs*

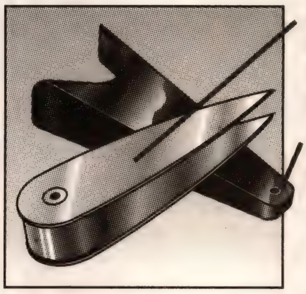


- Serrated for firmer hold with centre groove for gripping wire
- Internal cutter for snipping.
- Precision hand sharpened tip for miniature work.

- 5x Power magnifier glass provides a clear view for very fine work and splinter removal.
- Folds away for convenient storage.



- Box jointed for longer life and greater accuracy.
- Tension sprung for increased control and easy release.



- Super sharp hand finished tweezer for pin point accuracy.
- Convenient safety holder.

For *FREE* catalogue & list of stockists call:
**01388 420535**
Minicraft, Units 1&2, Enterprise City, Meadowfield Ave.
Spennymoor, Co. Durham DL16 6JF

MINICRAFT®

*Precision Tools for the Perfectionist*

# SEETRAX CAE RANGER PCB DESIGN

## WITH COOPER & CHYAN AUTOROUTER

RANGER2 + SPECCTRA £400.00

RANGER & SPECCTRA AUTOROUTER Together giving the most cost effective PCB design system on the market TODAY ! SEETRAX'S ease of use combined with **COOPER & CHYAN'S** renowned gridless autorouter, at an outstanding price.

R2 Outputs: 8/9 & 24 pin printers, HP Desk & Laser Jet, Cannon Bubble Jet, HP-GL, Gerber, NC Drill, AutoCAD DXF
Demo Disk available at £5.00 +VAT

RANGER2 £150

Upto 8 pages of schematic linked to artwork
Gate & pin swapping - automatic back annotation
Copper flood fill, Power planes, Track necking,
Curved tracks, Clearance checking,
Simultaneous multi-layer auto-router

RANGER2 UTILITIES £250

**COOPER & CHYAN SPECCTRA** auto-router (SPI)
Gerber-in viewer, AutoCAD DXF in & out

UPGRADE YOUR PCB PACKAGE TO RANGER2 £60

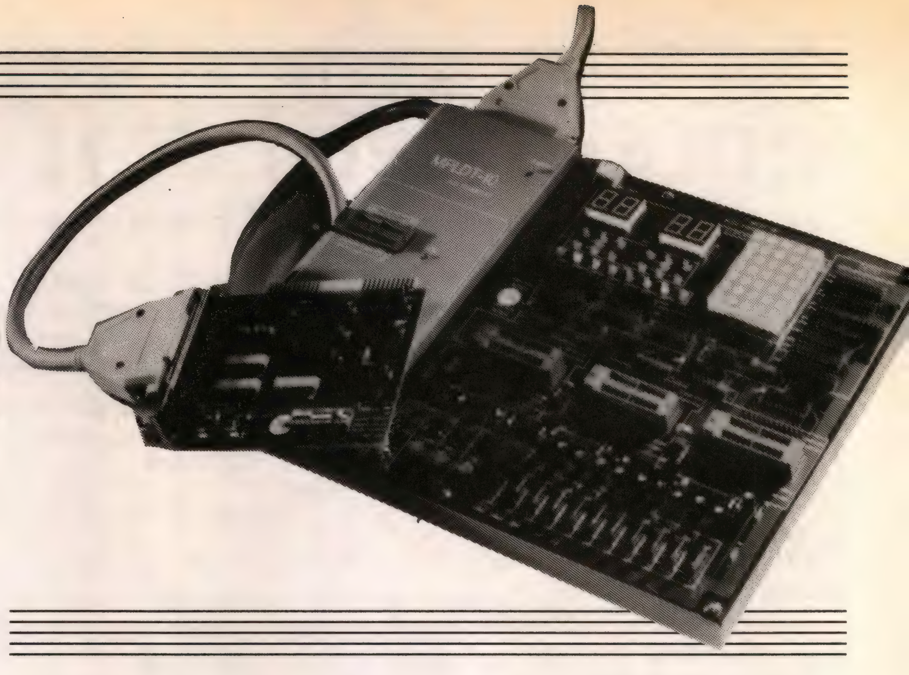
TRADE IN YOUR EXISTING PACKAGE TODAY

Seetrax CAE, Hinton Daubnay House, Broadway Lane, Lovedean, Hants, PO8 OSG
Call 01705 591037 or Fax 01705 599036 + VAT & P.P

All Trademarks Acknowledged

# PAL TRAINER REVIEW

## CHRIS ROBERTS



**Flight Electronics' PLD training system is an ideal tool for learning about and designing with programmable logic devices.**

THERE has been a revolution in the field of digital electronics in the last few years since the advent of programmable logic devices (PLDs). These are essentially single chips containing large arrays of simple logic gates that can be interconnected in different ways to achieve complex circuit designs.

The interconnections are programmable. Hence the same type of inexpensive chip can be used to implement a large number of different designs. This revolution has led to a great reduction in the development and production costs of highly complex electronic systems.

One of the major advantages of PLDs is the effect of design changes. These would normally require changes to a printed circuit board layout when conventional logic is being used. When PLDs are used, though, it may only be necessary to modify the program.

### PLD Training

It is very easy for both the hobbyist and the professional to be left behind when major revolutions occur. The main problem facing anybody trying to get to grips with such innovations has been that of choosing and obtaining the appropriate bits and pieces of hardware, the software needed to drive it, and sufficiently supportive documentation and information on how to make it all work!

The PC-based PLD training system reviewed here, the PAL Trainer supplied by Flight Electronics International Ltd., is a complete training system, comprising hardware, software and documentation, that has been designed specifically to fulfil this requirement. It is intended to be a complete self-teach package that would be beneficial in the workplace as a training system, but would have continued usefulness as a GAL (gate array logic) or PAL (programmable array logic) programming and testing system.

Its obvious application is as a training aid for use in colleges and training centres to promote understanding of PLDs at all levels.

### System Requirements

An IBM-compatible PC is required to operate the system, but it does not have to be particularly exotic! The minimum requirements are an IBM PC XT, PC AT, PS/2 or 100% PC-compatible computer with a minimum of 512KB of free system RAM and 10MB of hard disk space for the software. The operating system should be MS-DOS 3.1 or later.

### Hardware

The hardware includes a small interface card to be installed in the PC. This card only requires an 8-bit expansion slot. In the unlikely event of a conflict occurring, the I/O address can be changed to anything in the range 0 to 3FF hexadecimal by means of a 10-way dual-in-line switch on the card.

Connection of the interface card to the main unit is via a supplied cable having 37-way D-type connectors. The cable also provides the power for the main unit from the PC. The power supplies are protected by fuses on the interface card.

The main unit is constructed as a printed circuit board mounted on a sturdy metal case with external dimensions of approximately 30cm by 23cm. The left hand one-third of the unit is the GAL programmer. This section is totally enclosed by a metal cover that has a zero insertion force (ZIF) "Textool" socket mounted on it for programming and testing 20-pin or 24-pin GAL devices. One GAL 20V8 and three 16V8 devices are provided in the package.

GAL devices are electrically erasable programmable i.c.s that can be re-used to try out many different circuit designs. They can be used to emulate a large number of the one-time programmable PAL devices.

The remaining two-thirds of the main board is the experimental area. In the centre are three "Textool" sockets for receiving the GALs that the user has programmed in the programmer part of the unit. Their pin connections are brought out to rows of connectors on each side of the sockets. Patch leads are provided to enable connections to be made to the various input and output devices provided on the board:

There are 22 individual red, yellow and green l.e.d.s. They are arranged in patterns to facilitate the display of dice and traffic light patterns as well as for general use.

There are also four 7-segment l.e.d. displays which are ideal for building clock experiments. They are normally connected to 7447 decoder/driver chips and driven via these in 4-bit binary. However, the individual segments of one of the 7-segment displays can be driven directly by removing some jumpers provided on the board.

The third output system is a 5-by-7 dot matrix l.e.d. display. This can be driven to display a variety of symbols and patterns as well as alpha-numeric characters.

Input devices that can be connected to experimental GALs include ten individual slide switches that are all connected via debounce circuits to ensure clean high or low outputs. There are three debounced pushbutton switches, one of which has two complementary outputs.

Finally, three separate clock generators are included: one with a frequency of 1Hz; one at 10kHz; and one with a frequency that is variable from 1Hz to 1kHz.

This range of input and output facilities allows a wide range of practical experiments to be devised, as well as the testing of more complex designs by simulation.

### Demonstration Experiments

One of the novel features of the trainer is the provision of some demonstration experiments that allow the first time user to obtain interesting results fairly rapidly. To implement this feature, the top right corner of the main board has an area of connecting pins arranged in sets, each associated with a particular experiment.

By fitting sets of jumper links, all of the interconnections needed for a particular experiment, between the GAL sockets and the input and output devices, can be set up very rapidly and accurately. This is so that students can avoid the laborious task of connecting up patch leads. The jumpers used to make these connections are similar to those used on PC motherboards and expansion cards to select options. Those provided are moulded into blocks capable of linking up to nine pairs of pins at a time.

However, the problem is that the friction of this number of connectors is enormous. They are small and fiddly and not provided with any sort of handle or gripping device. Consequently, they are very difficult to remove. I had to resort to a pair of pliers to remove one of them and ended up breaking the plastic body of the connector.

Another area of concern was triggered by this problem with the jumpers. Whilst attempting to prise them off with a screwdriver, I was conscious of the danger of an accidental short-circuit between pins. There is no power switch on the main unit and the connecting cable carries prominent red labels warning that the system's power should be switched off before connecting or disconnecting. Thus, to play safe, it appeared necessary to switch off the PC when removing the jumpers.

*(Flight Electronics advise that the red labels refer to the programming section, not the experimental section, which has no power connections available to short-circuit as they are hidden. Ed.)*

## Software

Two software packages are provided with the training system. The first, called PGAL, is produced by Flight Electronics and is the program to operate the GAL programmer. It runs under MS-DOS and was very easy to install and use. It is menu driven and provides the following facilities:

**EMULATION:**
Modes can be selected whereby one of the two types of GAL provided can be used to emulate one of a large range of industry standard PAL types.

**DOWNLOAD:**
Loads a JEDEC standard programming file from disk into the PC memory ready for programming the GAL. This is the standard type of file generated by PLD design software such as PALASM 4. A number of demonstration files are provided with the software package, as described later.

**PROGRAM:**
Used to program the GAL in the programmer ZIF socket with the JEDEC file loaded into memory by the "download" facility.

**VIEW:**
Enables the contents of the PLD in the ZIF socket to be read.

This software was found to be very simple to use. I was able to work quite quickly through the examples provided, programming the GALs and trying out the designs on the experimental area of the trainer.

## Professional PLD Software

The second software package provided with the training system is PALASM 4 produced by Advanced Micro Devices (AMD). This is a full blown professional PLD design system, widely regarded as the standard. It has to be installed from four diskettes and is supplied with two thick reference manuals. The software also runs under MS-DOS and is menu driven.

Because this is the full professional design system, it is very powerful and has many features. As a consequence it takes a little longer to find one's way around. There are worked examples provided both in the AMD reference books and in the Flight Electronics manual for the training system which ease the learning process considerably.

The software allows you to enter the details of your own logic design and convert it into the data required for programming the PLD. The first step is to designate the pin numbers that will correspond to the inputs and outputs of your circuit. The function of the circuit is then defined using Boolean algebra expressions relating to the designated pins. A simulation can then be performed to verify the function of the circuit design. The final stage is to compile the JEDEC file that will be used to program the PLD.

There is also a facility to link the program to the popular electronics CAD program OrCAD SDT/III. This facility allows the logic design to be entered as a schematic diagram instead of a text file containing Boolean expressions. Unfortunately, I did not have the facility to try this approach.

The software provided makes it possible to design complex logic circuits and implement them very rapidly in silicon. They can then be tested in the experiment area of the trainer.

## Documentation

As already mentioned, PALASM 4 is supplied with its own manuals: a "getting started" workbook and a comprehensive reference manual. Together these cover the use of the PLD design software very thoroughly. In addition, and generally more useful initially, is the "user manual" for the training system provided by Flight Electronics.

This is very clearly presented in a user-friendly style. It covers the installation of the hardware and software very comprehensively. The philosophy of the manual is to lead the user quickly through the installation process and a brief tutorial on the software, into some practical experiments using example PLD programming files provided with the software. This captures the user's attention at an early stage by allowing him or her to produce some interesting results fairly rapidly.

It is a technique that works very well. There are four demonstration programs which range from producing dice patterns on a group of l.e.d.s to a four-digit 24-hour clock. The latter design, for demonstration purposes, uses three GALs to drive the hours, minutes and seconds displays.

After working through this tutorial the user should quickly become quite competent at using the programmer and experimental board. This naturally encourages users to progress to creating designs using PALASM. The system is then being used as a design tool rather than just a teaching aid.

The last chapter of the user manual is a tutorial on using PALASM 4. It contains 17 worked examples of producing combinational and sequential logic designs. These examples include those used for the four demonstrations in the introductory tutorial.

The user manual supplied is very impressive. Flight Electronics say that some minor omissions and errors in the one received have been corrected in the new version now released. They have gone to great lengths to make it easy to use, employing a step-by-step tutorial style.

For a total newcomer to PLDs, I felt that it would be useful to include a general introduction to these devices that explains the differences between the terms PLD, PAL, GAL etc. However, when this was discussed with Flight Electronics they advised that it has been done in the revised version of the manual.

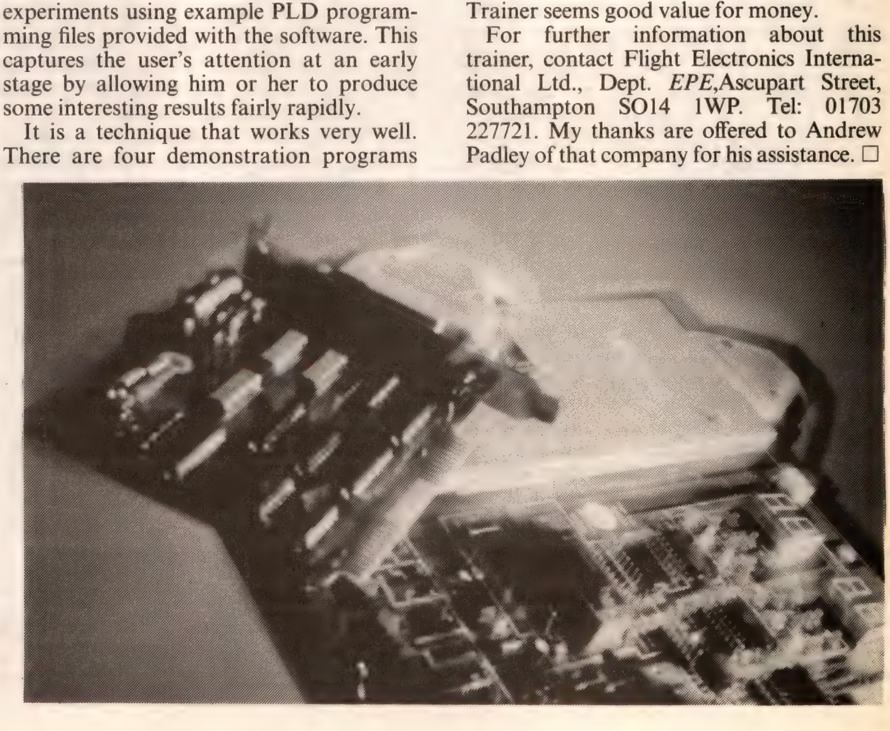
## Overall Impression

The system as reviewed provides an easy-to-use introduction into the world of PLDs. The excellent user manual means that the system could be used as a self-teach package. Provision of the professional PALASM 4 design software also means that the system is useful in a working environment as a design tool when not required for training purposes.

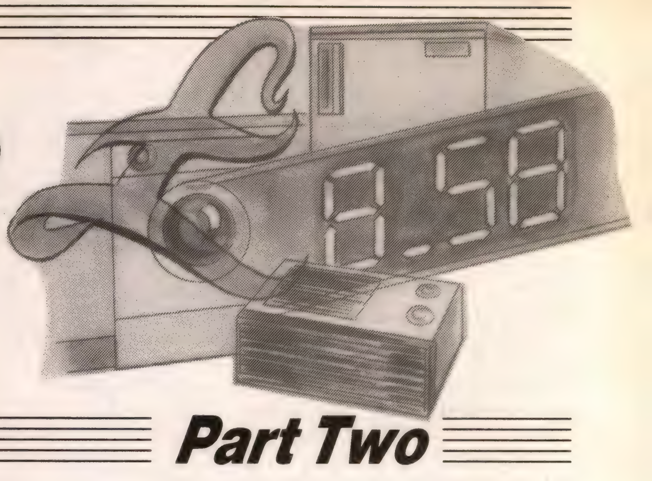
It would make a superb teaching aid for colleges of further and higher education, although I am not sure how student-proof it would be with the jumper removal problems.

Considering the whole package, which costs £695, the Flight Electronics PAL Trainer seems good value for money.

For further information about this trainer, contact Flight Electronics International Ltd., Dept. *EPE*, Ascupart Street, Southampton SO14 1WP. Tel: 01703 227721. My thanks are offered to Andrew Padley of that company for his assistance. ☐



## Constructional Project



# PIC-ELECTRIC METER

### JOHN BECKER

### Part Two

*Know just how much each electrical appliance in your home is adding to your electricity bill.*

LAST month the operating theory and circuit details, including the special current transducer, for the PIC-Electric Meter were introduced. This concluding article covers the practical construction, testing procedures and using the Meter.

## SOFTWARE

Software of the source-code listing for the PIC-Electric Meter (together with last month's Simple PIC16C84 Programmer software) can be supplied from the Editorial Office as a 3·5in. disk (UK £2.50, overseas surface £3.10, airmail £4.10). A pre-programmed PIC16C84 chip (together with p.c.b.s) for PIC-Electric, ready to plug straight in, is obtainable from Magenta Electronics. See *Shoptalk* for details.

*Readers who buy the pre-programmed chip do not need to have a computer in order to build this project.*

## CONSTRUCTION

Two printed circuit boards (p.c.b.s) are used in the PIC-Electric Meter, the Sensor and PSU p.c.b. and the Control and Display p.c.b. They are available from the *EPE PCB Service,* codes 977 (Sen./PSU) and 978 (Cont./Dis), respectively. Their topside component positioning and full-size copper foil track master layouts are shown in Fig. 7, Fig. 8 and Fig. 9.

Start assembly of the boards by inserting the on-board wire links, two of which pass under i.c.s. Continue by inserting the resistors and diodes. Next, solder in the d.i.l. i.c. sockets. The remaining components can then be inserted in any order found to be most convenient.

Make sure that all polarity-conscious components are correctly orientated. Capacitors C7, C11 and C12 are mounted on the rear of the p.c.b. to keep a low profile on top of the board. Crystal X2 is mounted flat with the top of the board. A sub-miniature l.e.d. is suggested for D9 because of its low height.

If you do not intend programming your own PIC microcontroller, diode D7 may be replaced by a link wire and the following components may be omitted: S1, D8, D9, D10, R19, R22, R23.

The pushbutton switches, S2 to S4, used in the test model were short shafted types requiring the use a pencil or similar to access them through the case holes. Long shafted types, if available, may be substituted if preferred. Slide switch S1 is a plastic p.c.b. mounting type, with both sets of contacts connected in parallel on the board.

## DISPLAY

Mounting the display module X3 first requires rigid wires to be soldered into its required connection holes (not all holes are used, as will be seen in Fig. 7). Some wires and holes may need to be soldered on both sides, as examination of the display module will show. Resistor off-cut wires can probably be used, though 25mm lengths of 24s.w.g. tinned annealed copper wire cut from a bobbin will prove more convenient.

Trim the loose wire ends to the same length, straighten and align them, then (patiently!) insert them into the p.c.b. holes.

**SPECIFICATION . . .**

***There are six basic display functions available:***

- ★ **Cost per unit of electricity to 99·99 pence**
- ★ **Units of electricity used to 9999·99**
- ★ **Cumulative cost to 99 pounds 99·99 pence**
- ★ **Elapsed time to 159 hours 59 minutes and 59 seconds**
- ★ **Instantaneous current flow up to 15A**
- ★ **Initial setting-up (very simple)**

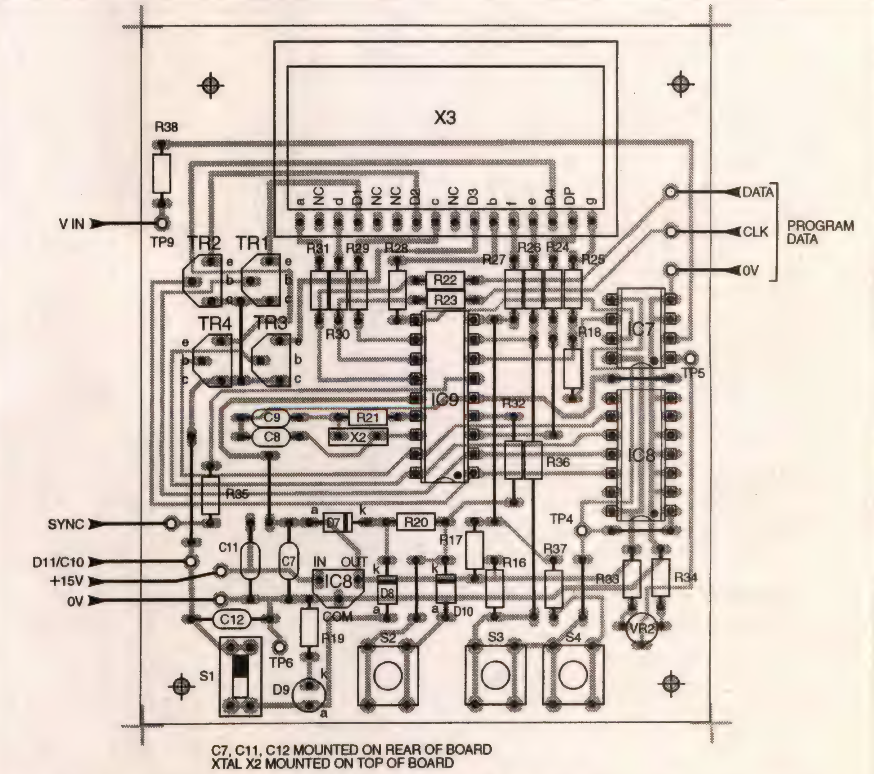


*Fig. 7. Component layout for the Control and Display printed circuit board.*

If a wire is reluctant to go into a hole, a thin bladed screwdriver can be used to assist. Make sure all wires are inserted, then press the display flat to the p.c.b. and solder the underside protruding wires to their pads.

Insert 1mm terminal pins into the boards for the test points (TP) and low voltage connecting wires.

## CASE DETAILS

A plastic case measuring 188mm × 108mm × 160mm was used to house PIC-Electric. All holes should be carefully marked before drilling to ensure that they align with the p.c.b.s.

An oblong hole (see photographs) needs to be cut in the right-hand side of the lid for the display to be seen. This can be easily achieved by drilling a series of small holes around the inner perimeter of the area to be removed. Careful use of a chisel will make the final cuts between the holes, after which the edges can be filed to shape.

Three holes are needed to suit the push-button switches, and two holes in the side for the mains cable entry and exit glands. Four more holes are required for the bolts which secure the display board to the inside of the lid. It is best not to bolt this board in position until testing and PIC programming are complete.

The Sensor and PSU p.c.b. is bolted to the left-hand side of the base of the case via suitably positioned holes.

***Mains carrying input and output cables MUST be capable of handing the maximum currents drawn by appliances which are to be monitored.*** Normal household 13A 3-core mains cable will normally be suitable. In the test model, the output cable was terminated by a 4-way 13A socket block enabling several appliances to be monitored simultaneously. Other sockets could be used instead.

A separate fuse was not used with the test model, though one may used if preferred, mounting its fuseholder in the side of the

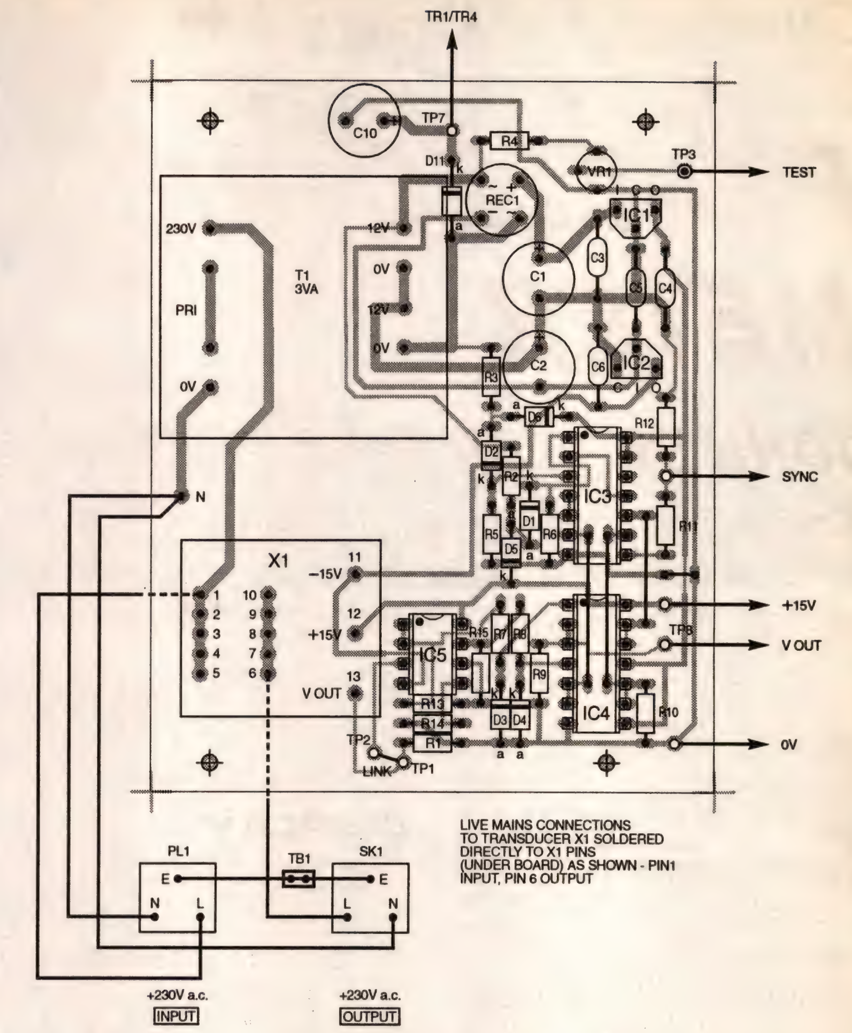


*Fig. 8. Printed circuit board component layout and wiring for the Sensor/PSU board.*

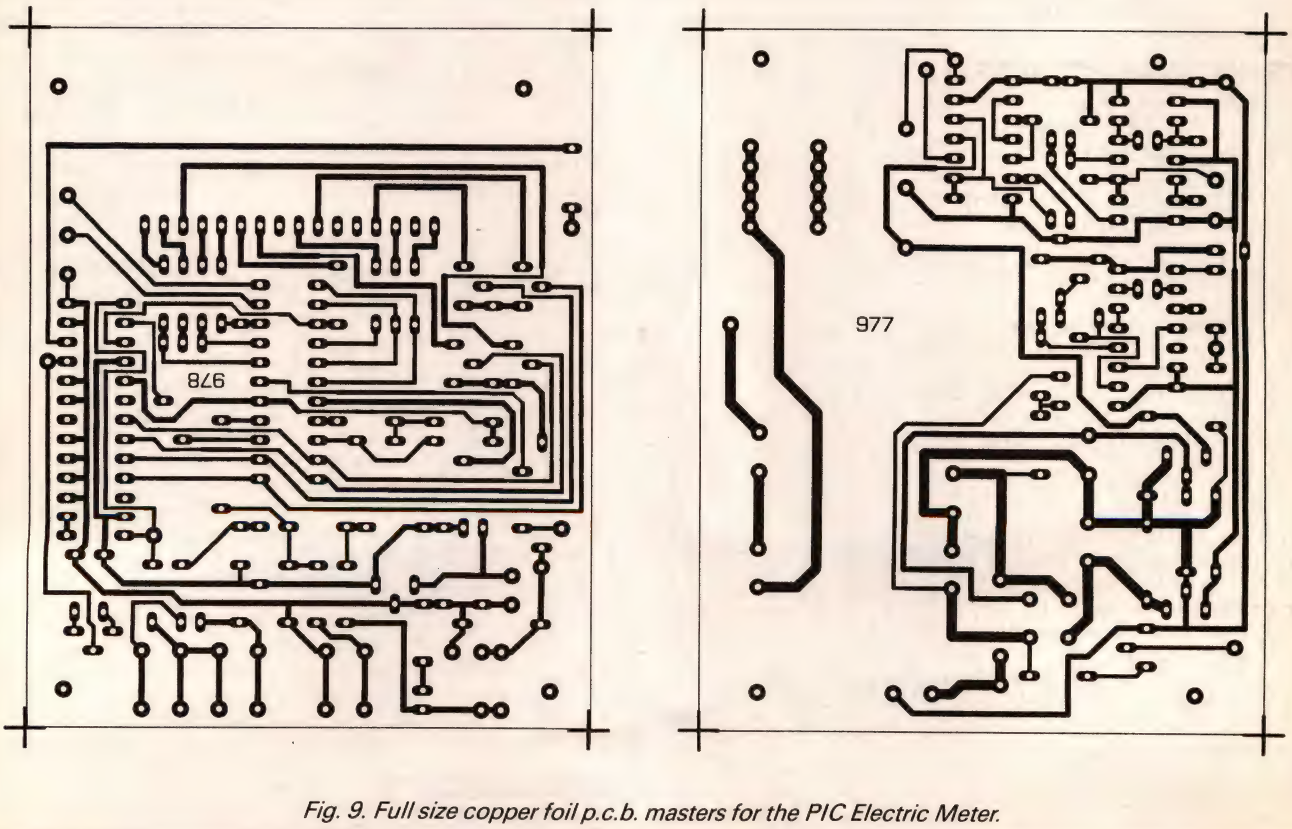
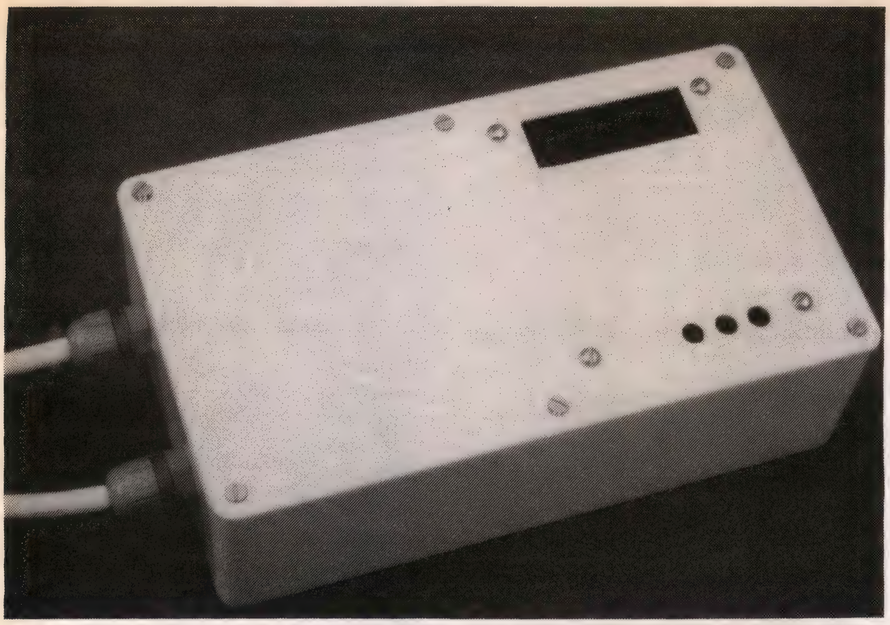


*Fig. 9. Full size copper foil p.c.b. masters for the PIC Electric Meter.*



*Finished PIC-Electric Meter showing display cutout and three access holes for the function switches.*

box. It must be rated to suit the appliances monitored.

Interwire the boards and make all external connections. The mains cables are soldered *directly* to the copper track side of the board, as indicated in Fig. 8.

Thoroughly check the complete assembly for component positioning accuracy and satisfactory soldering. Do not insert any of the d.i.l. i.c.s. yet. Set programming slide switch S1 off (towards rear of the p.c.b.).

## FIRST TESTS

***Beware that while PIC-Electric is plugged into the mains supply, potentially lethal voltages will be present within its case.*** If in any doubt about the assembly or testing, consult a competent electrician.

As warned earlier, this is not a project for the inexperienced. Always *unplug* the unit from the mains *before* making any assembly changes.

Do not plug any appliance into the output monitoring socket SK1 yet. Plug the unit into the mains and immediately check for the following voltages:

IC1 output pin: +15V
IC2 output pin: −15V
IC8 output pin: +5V
TP7: greater than +17V

If the three fixed voltages are not within about five per cent of nominal, recheck the assembly.

Unplug the "meter" from the mains supply and insert the remaining i.c.s, observing the usual anti-static handling precautions. Plug into the mains again and recheck the voltages.

The fixed voltages should be at the same values. If the microcontroller has already been programmed, though, the voltage from TP7 which powers the display, may now fluctuate from its previous maximum down to around +7V, or so, depending on which segments are active.

Monitor test point TP5, the reference voltage pin of the ADC (IC7), and adjust preset VR2 so that a reading of 1·530V is achieved, a value chosen to simplify the data processing routines.

## SOFTWARE OPERATION

When the unit is first switched on, or is reset by pressing switch S2, the software first of all performs a few necessary setting-up procedures. One of these procedures being to read the EEPROM data memory for the stored value of the cost of each electricity unit, the Unit Cost.

An arbitrary value is assigned if the EEPROM memory has not yet been programmed by the user. A delay factor is also recalled from EEPROM memory.

Following the set-up routines, the status of Function switch S4 is read. If the switch is pressed, a Test and alignment routine flag is set, which is discussed later. Irrespective of S4's status, the program goes into a "holding loop" from which it waits for the occurrence of a sync pulse on the processor's RB0 data line.

## INTERRUPTS

The holding loop is returned to at the end of each processing cycle of commands, which are initiated 100 times a second in response to the sync pulse received. The microcontroller has its initial parameters set by the program so that the sync pulses are treated as interrupts.

As soon as each interrupt is received, the program immediately jumps to a specifically allocated routine. At the end of the routine, it automatically returns to the point from which it jumped. Using this technique means that sync pulses do not need to be specifically looked for by the software.

However, use of an automatic interrupt procedure should be treated with caution if writing routines for other applications. Irrespective of where the software is in its processing cycle, received interrupts will automatically divert the microcontroller's attention to the predetermined routine in the program.

Unless suitable precautions are taken, this action could result in routines being disrupted and their intended functions corrupted. In PIC-Electric, the timing of other routines ensures that they are complete long before the next interrupt is due.

## DISPLAY ROUTINE

On receipt of each sync pulse interrupt, the program jumps from the holding loop direct to the display routine and outputs data to the appropriate digit. Different digits of the multiplexed display are activated each time the display routine is called.

Software uses a look-up table to convert the decimal value for each digit (which can range from 0 to 15) to the correct binary code which activates the relevant l.e.d. segments. Code bits are set to zero to turn on the respective segment.

A timed delay loop is entered after the display routine has been run following the interrupt. At the end of this routine (assuming the Test flag has not been set) the main routine of ADC sampling and counter updating proceeds.

Following this sequence, the display routine is again called and data output to the next appropriate digit, after which the main holding loop is again entered. Doubly calling the display routine in this way increases its multiplexed rate to 200Hz, so eliminating a flicker effect which was apparent when multiplexed at 100Hz.

## OPTIMISING SYNC

The next step in testing is to adjust the delay time setting and to optimise the point during the mains supply sinewave at which the ADC is sampled. The same action corrects for both factors and is carried out while the software is set to Test mode.

In order to simplify testing without having a mains appliance plugged in, the simple test circuit (R4 and VR1) in Fig. 5 is used at this stage. Remove the link wire between test points TP1 and TP2. Connect TP3 to TP1.

This links preset VR1 to the analogue processing circuit around IC5. Set VR1 to provide a sinewave of reasonable amplitude, about 0·7V a.c., for example. (If viewed on an oscilloscope, the waveform will appear a bit misshapen due to the total load on the transformer.)

Test mode is called up by having Function switch S4 already pressed when Reset switch S2 is pressed to reset the microcontroller. When S2 is released, followed by the release of S4, the Test flag is set and the program then automatically jumps to the test routine after completing the first display routine called at each 100Hz interrupt.

The waveforms which illustrate the timing required were shown in Fig. 4e to Fig. 4g last month. The latter waveform represents the analogue data presented to the ADC IC7. Fig. 4e shows the sync pulse.

Software jumps from its holding loop on the rising edge of each pulse, performs the display routine and enters the timed delay loop. At the end of this loop, ADC sampling occurs, as indicated by the negative-going pulse in Fig. 4f.

Ideally, the sampling pulse should occur midway between two rising edges of the sync pulse and at the peak of the analogue waveform. In reality, the precise timing of the sampling is not too critical since the plateau of the processed sensor waveform is fairly broad and flat, especially in comparison with the resolution of the ADC and the maximum voltage range with which it has to cope.

Of greater significance, perhaps, is the timing of the second display routine which follows the sampling. If this routine does not occur at roughly the midway point between sync pulses, an imbalance in alternate digit brilliance can occur.

For example, digits one and three can appear brighter than digits two and four, or vice versa. Correcting the length of the delay loop balances the respective brilliances and also, by programming design, optimises the sampling point of the analogue voltage.

## DELAY TIME

Pushbutton switches S3 and S4 are used to correct the delay timing. Pressing S3 retards the sampling point, pressing S4 advances it.

Note, though, that if either point is taken too far, the sampling point reverts to a default value. The switches should be appropriately pressed until all four digits have similar brightness.

An oscilloscope will show the optimum point more precisely, but is not really necessary. If one is used, set sync to Channel 1, either positive or negative, and clip the probe for this channel to test point TP4. Clip the probe for Channel 2 to TP9, the analogue input to the ADC. Pressing either of switches S3 or S4 will be seen to shift the relationship between the two waveforms of Fig. 4f and Fig. 4g.

While the delay loop timing is being adjusted, the hexadecimal ADC value shown on the central two digits of the display will also be seen to change. The outer two digits are intentionally blank at this time. A maximum value will indicate the optimum sampling point of the analogue waveform.

Preset VR1 can be adjusted to change the analogue test voltage amplitude. The displayed value will change accordingly between hexadecimal extremes of 00 and FF (0 to 255 decimal).

If the ADC reference voltage preset VR2 is adjusted out of curiosity, the display value will also change, but make sure VR2 is eventually returned to its original voltage setting.

## TESTING TIME-OUT

A time-out period of about 40 seconds has been written into the testing routine. At the end of this period, the delay value set by switches S3 and S4 is automatically stored in EEPROM memory, following which normal sampling and display commences.

This value will be recalled each time the PIC-Electric is switched on or reset using switch S2. No provision has been made to display the actual value of the delay timing.

If alignment has not been completed by the end of the time-out, re-initiate the test sequence as before, using switches S2 and S4. Once initiated, there is no way to override the time-out period, except by pressing reset switch S2, or switching off the power.

Once delay timing has been optimised, disconnect the wire between TP3 and TP1. Reconnect TP1 to TP2, so restoring X1 sensor signal to the circuit around IC5.

## PRICE SETTING

The price per unit of electricity can be now changed.

Reset the unit by pressing switch S2 and watch the display. An arbitrary "Unit Cost" value will be seen with its left-hand digit flashing slowly on and off.

Pressing Function switch S3 causes the value of the flashing digit to be incremented at about 1Hz, passing back through zero after nine. Set the number to suit the tens of pence of the known price charged by the Electricity Board for each unit used (see your last electricity bill).

Press Function switch S4. The next digit will now flash, representing single pence of the cost. Press S3 to increment the price to the correct value. Repeat the process for the last two digits, representing the decimals of pence cost.

Now either press S4 or wait for the cost time-out period to end (see below). In either case, the new cost will be automatically stored in the EEPROM memory and normal monitoring commenced. The cost value will remain stored in memory until changed on some future occasion. It is not erased when the unit is switched off.

Correct storage of the new cost can be checked by pressing S2 to reset the unit, whereupon the display should show the new value. If S2 is pressed before the end of the cost changing procedure, the original value will be retained.

## COST TIME-OUT

A time-out counter is incremented during Unit Cost display. The counter is reset to zero each time S3 or S4 is pressed. At the end of the time-out period, approximately ten seconds, one of two routines is called.

If either S3 or S4 has been pressed during this period, the prevailing Unit Cost value is stored in EEPROM as above. If neither switch has been pressed, the EEPROM store routine is bypassed.

There are two principles attached to this technique. Firstly, when first plugged in or reset, the meter will automatically start monitoring any connected mains appliances at the end of the time-out period without intervention of the user. Secondly, it avoids writing to the EEPROM memory except when necessary, even though its useful lifetime is in excess of one million write cycles.

Unnecessary writing to it is wasteful of its life! There is no practical limit to the number of times it can be read.

## USER-READY

After the delay loop timing and unit price factors have been set, PIC-Electric Meter is ready for use. Unplug from the mains supply, plug the appliance to be monitored into the unit, a 100W lamp is suggested at this time.

Plug the unit back into the mains. As soon as power is applied, it will first pass through its normal initialisation routine, through the cost change time-out period, and into the main monitoring routine.

With a 100W lamp as the load, it will take about six minutes before a units-used reading of 00·01 will be seen. Depending on the price factor stored, a cost total of 00·01 pence should appear after only a few tens of seconds. (Note that 100W lamps will only nominally draw 100W – they have a wide tolerance factor!)

## DATA GATHERING

Following the Unit Cost assessment routine, PIC-Electric goes into its main data gathering routine in which the ADC conversion value is read.

Ideally, each value read from the ADC should be added to a total which is then multiplied or divided to arrive at the actual electricity units used and their overall cost. The PIC16C84, though, does not have multiply or divide commands as part of its RISC (reduced instruction set commands) instruction armory. Although such instructions can be written as software routines, the number of commands involved is, in this application, too lengthy for a chip having only 1K bytes of program data memory available.

Consequently, an additive technique which does not require multiplication or division is used to cumulatively add fixed fractional values to running totals of units used and their cost. The addition is made each time the 100Hz interrupt occurs and according to the ADC value read. It is mostly carried out in decimal mode, as opposed to binary, making the most significant decimal places of the totals easy to access and display.

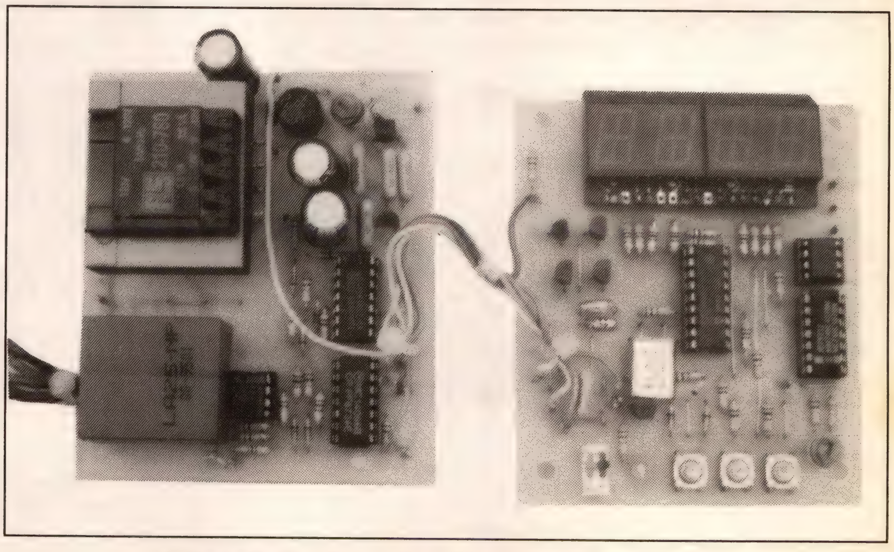
During the normal display mode, the source of the data displayed changes about every three or four seconds. The following is an example of a typical sequence:

1. Hundreds of units used: U- 01 (Units = 100)
2. Tens of units used : 51·74 (+ 51·74 units, total = 151·74)
3. Tens of pounds cost : C- 10 (Pounds = 10)
4. Tens of pence cost : 81·90 (+ 81·90 pence, total = 10·81·90p)

During stages 1 and 3, the letters U or C show whether Units or Cost is being displayed. Additionally in stages 1 and 3, the central segment of the second digit from the left is turned on if the ADC value is above zero, it is otherwise turned off.

This instantly shows whether an intermittent appliance, such as a fridge or washing machine, is actually drawing current at that moment. Thus the example display indicates that the appliance was consuming current when the reading was noted.

When the cost is below ten pounds, or the units used are below 100, the right-hand two digits of the display in stages 1 or 3 are turned off, as relevant.



*Completed circuit boards ready for housing in their case.*

## ELAPSED TIME DISPLAY

An elapsed time counter is reset to zero at the end of the initial setting up sequence and subsequent unit cost assessment time-out period. The counter is incremented in one hundredths of a second at each interrupt. At the appropriate count, memory locations for seconds, minutes and hours are updated. The elapsed time can be displayed by pressing switches S3 and S4 at any time while PIC-Electric is monitoring current and without disrupting the accuracy of the units and cost counts.

Pressing S3 displays the Hours and Minutes count. Elapsed Minutes and Seconds are displayed when S4 is pressed. Beyond 99 hours, the left-hand digit shows the tens of hours in hexadecimal, as capital or lower case letters to suit a seven-segment display: A = 100 hours, b = 110, C = 120, d = 130, E = 140, F = 150. Beyond a count of F9 hours 59 minutes 59 seconds, the elapsed time restarts from zero.

## ADC VALUE DISPLAY

The instantaneous value of the ADC count, in binary, can also be displayed at any time without disrupting the various counting routines. Pressing switches S3 and S4 together initiates this display routine.

It does not matter in which order they are pressed or released, as long as both are at some point simultaneously pressed the display will be triggered. The display will continue to show the ADC value for about 15 seconds after the switches are released.

Ideally, it would have been advantageous to show the ADC value as an amperage quantity in decimal. Regrettably, the necessary conversion routines which it is possible to write for a PIC16C84 are lengthy and comparatively slow to process, making their use in this unit untenable. The use of another look-up table would also take up too much chip program memory.

However, readers should have no significant difficulty in arriving at a rough approximation amperage value. If greater accuracy is required, use an ammeter!

## PIC16C84 PROGRAMMING

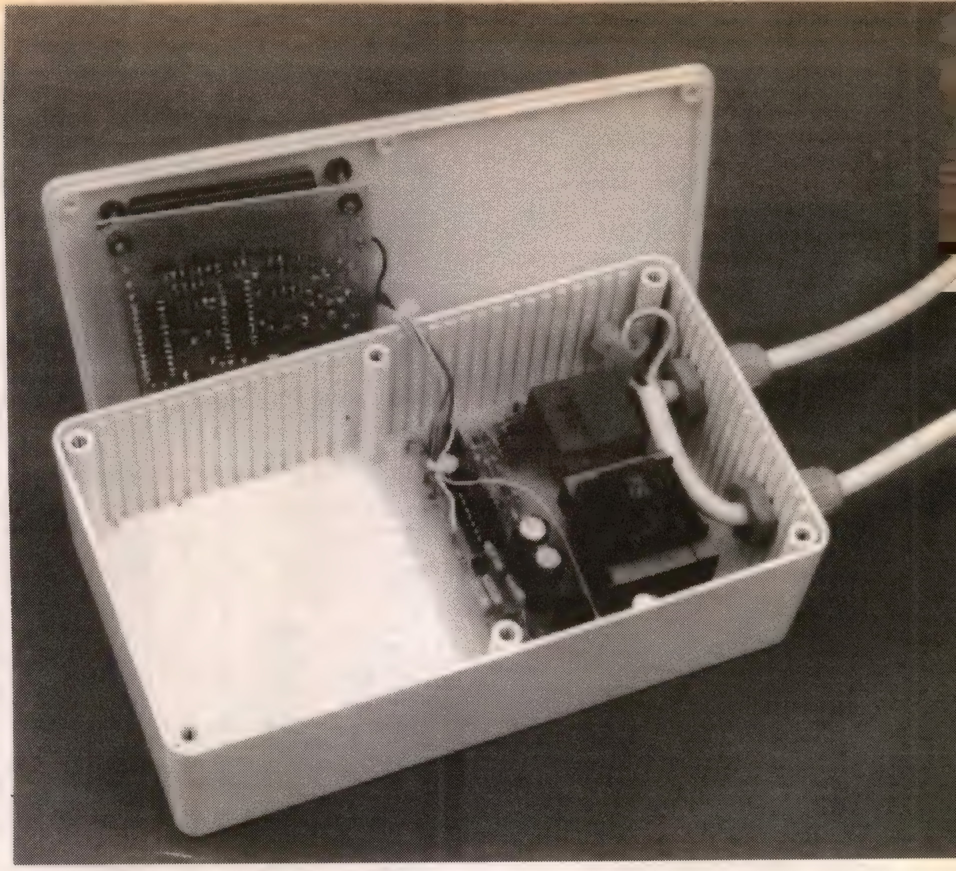
To program the PIC16C84 in situ, the following items are needed:

- PC-compatible computer
- PIC-Electric source code
- Suitable assembler and serial transfer software, such as that associated with the *Simple PIC16C84 Programmer* published last month
- PC parallel port connector with a 3-way cable of about one metre, unterminated at the far end

Solder the wires of the serial connecting cable to their designated points on the PIC-Electric board (see Fig. 7). Plug the connector into the computer's parallel port. Plug the PIC chip into the PIC-Electric board. Load the assembler software and compile the source code into a .OBJ (object file, commonly pronounced "dot O. B. J.") format.

Apply power to PIC-Electric, switch on S1 and check that l.e.d. D9 is on. If programming a PIC chip for the first time on the board, it is advisable to also check that +12V is present at IC9 pin 4 ($\overline{MCLR}$ pin). Run the serial transfer software.

The computer screen will ask if the PIC chip needs to be initialised. It will need to be on the first occasion that it is to be programmed.



*The Sens/PSU board mounted in the base of the case and the Cont/Dis. p.c.b. secured to the inside of the lid.*

A choice of oscillator type will be presented:

1. LP low power crystal oscillator (32kHz to 200kHz)
2. XT crystal oscillator (100kHz to 4MHz)
3. HS high speed crystal oscillator (4MHz to 10MHz)
4. RC resistor/capacitor oscillator

Select the XT crystal oscillator function. The Watchdog Timer is not used by PIC-Electric, but when asked if it should be enabled, answer *yes*. The Power-up Timer is required, so respond that it should be enabled.

After the above questions have been answered, the chip will be initialised by the software. The PIC-Electric's .OBJ program codes can now be automatically downloaded to the chip in response to further simple screen prompts.

The screen will advise when down-loading is complete. Then switch off S1 to remove the +12V programming voltage from the chip and turn off the l.e.d. Press Reset switch S2. The PIC-Electric software will immediately start functioning.

Should it be necessary to again download a .OBJ file for any reason, if the program has been modified, for example, it will not normally be necessary to re-initialise a PIC chip. The author has had to do on one occasion, though. Inadvertently, programming switch S1 was opened during data transfer and the chip thereafter refused to be re-programmed until it had been re-initialised.

## OTHER COUNTRIES

It seems probable that the PIC-Electric Meter could be modified to suit mains voltages lower than the 230V a.c. used in Britain, *providing the frequency is 50Hz*. (It is not suitable for 60Hz use). The transformer will need changing to one having the appropriate rating, but otherwise its seems that the only change needed is to alter the setting of the ADC's reference voltage.

The value required can be established by monitoring a fixed load for an exact period, comparing the displayed results with those calculated. The unit cost of electricity can be entered in any currency, although decimal places may be incorrect.

## IN USE

Three questions in particular have been answered for the author using PIC-Electric Meter. The first concerns a 35-year old fridge which it was thought might be so expensive to keep on running that it would be more economical to replace it.

In a 24-hour sampling period, at the height of summer, PIC-Electric showed that it cost only 4·5p to run; obviously not worth replacing it. It compares favourably with a modern fridge/freezer of three times the capacity in the same kitchen, which cost 14p for a similar period, although the latter is more frequently opened. The very large 15-year old freezer in the garage cost 33p for the same period (a bit of an unwelcome surprise!)

The second question concerned how much a washing machine cost for similar loads on the same program cycle when having to heat its own water compared to being provided with hot water from the main domestic system. The answers were 50p and 10p, respectively, although the cost of heating the domestic tank could not be established since it is gas fired and was being used for general heating at the same time.

Thirdly, how much was the tumble dryer costing to dry an average Saturday's wash for two adults? Answer: 42·5p.

It is acknowledged, of course, that the cost of building the PIC-Electric Meter must be taken into account when considering the potential savings which could be achieved by using it. The proportional cost, though, can be improved if a group of neighbours combines to buy it. Or perhaps you could hire it out and make money! ☐

**PORTABLE X RAY MACHINE PLANS** Easy to construct plans on a simple and cheap way to build a home X-ray machine! Effective device, X-ray sealed assemblies. can be used for experimental purposes. Not a toy or for minors! £6/set. Ref F/XP1.

**TELEKINETIC ENHANCER PLANS** Mystify and amaze your friends by creating motion with no known apparent means or cause. Uses no electrical or mechanical connections, no special gimmicks yet produces positive motion and effect. Excellent for science projects, magic shows, party demonstrations or serious research & development of this strange and amazing phychic phenomenon. £4/set Ref F/TKE1.

**ELECTRONIC HYPNOSIS PLANS & DATA** This data shows several ways to put subjects under your control. Included is a full volume reference text and several construction plans that when assembled can produce highly effective stimuli. This material must be used cautiously. It is for use as entertainment at parties etc only, by those experienced in its use. £15/set. Ref F/EH2.

**GRAVITY GENERATOR PLANS** This unique plan demonstrates a simple electrical phenomena that produces an anti-gravity effect. You can actually build a small mock spaceship out of simple materials and without any visible means- cause it to levitate. £10/set Ref F/GRA1.

**WORLDS SMALLEST TESLA COIL/LIGHTENING DISPLAY GLOBE PLANS** Produces up to 750,000 volts of discharge, experiment with extraordinary HV effects, 'Plasma in a jar', St Elmo's fire, Corona, excellent science project or conversation piece. £5/set Ref F/BTC1/LG5.

**COPPER VAPOUR LASER PLANS** Produces 100mw of visible green light. High coherency and spectral quality similar to Argon laser but easier and less costly to build yet far more efficient. This particular design was developed at the Atomic Energy Commision of NEGEV in Israel. £10/set Ref F/CVL1.

**VOICE SCRAMBLER PLANS** Minature solid state system turns speech sound into indecipherable noise that cannot be understood without a second matching unit. Use on telephone to prevent third party listening and bugging. £6/set Ref F/VS9.

**PULSED TV JOKER PLANS** Little hand held device utilises pulse techniques that will completely disrupt TV picture and sound! works on FM too! DISCRETION ADVISED. £8/set Ref F/TJ5.

**BODYHEAT TELESCOPE PLANS** Highly directional long range device uses recent technology to detect the presence of living bodies, warm and hot spots, heat leaks etc. Intended for security, law enforcement, research and development, etc. Excellent security device or very interesting science project. £8/set Ref F/BHT1.

**BURNING, CUTTING CO2 LASER PLANS** Projects an invisible beam of heat capable of burning and melting materials over a considerable distance. This laser is one of the most efficient, converting 10% input power into useful output. Not only is this device a workhorse in welding, cutting and heat processing materials but it is also a likely candidate as an effective directed energy beam weapon against missiles, aircraft, ground-to-ground, etc. Particle beams may very well utilize a laser of this type to blast a channel in the atmosphere for a high energy stream of neutrons or other particles. The device is easily applicable to burning and etching wood, cutting, plastics, textiles etc £12/set Ref F/LC7.

**MYSTERY ANTI GRAVITY DEVICE PLANS** Uses simple concept. Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or science project. £6/set Ref F/ANT1K.

**ULTRASONIC BLASTER PLANS** Laboratory source of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquides. Many cleaning uses for PC boards, jewllery, coins, small parts etc. £6/set Ref F/ULB1.

**ULTRAHIGHGAIN AMP/STETHOSCOPICMIKE/SOUND AND VIBRATION DETECTOR PLANS** Ultrasensitive device enables one to hear a whole new world of sounds. Listen through walls, windows, floors etc. Many applications shown, from law enforcement, nature listening, medical heartbeat, to mechanical devices. £6/set Ref F/HGA7

**ANTI DOG FORCE FIELD PLANS** Highly effective circuit produces time variable pulses of accoustical energy that dogs cannot tolerate £6/set Ref F/DOG2

**LASER BOUNCE LISTENER SYSTEM PLANS** Allows you to hear sounds from a premises without gaining access. £12/set Ref F/LLIST1

**CRAWLING INSECT ROASTER PLANS** Harmless high frequency energy pulses destroy pests as they crawl into the energy field! £4/set Ref F/RCR1

**LASER LIGHT SHOW PLANS** Do it yourself plans show three methods. £6 Ref F/LLS1

**PHASOR BLAST WAVE PISTOL SERIES PLANS** Handheld, has large transducer and battery capacity with external controls. £6/set Ref F/PSP4

**INFINITY TRANSMITTER PLANS** Telephone line grabber/room monitor. The ultimate in home/office security and safety! simple to use! Call your home or office phone, push a secret tone on your telephone to access either: A) On premises sound and voices or B) Existing conversation with break-in capability for emergency messages. £7 Ref F/TELEGRAB.

**BUG DETECTOR PLANS** Is that someone getting the goods on you? Easy to construct device locates any hidden source of radio energy! Sniffs out and finds bugs and other sources of bothersome interference. Detects low, high and UHF frequencies. £5/set Ref F/BD1.

**ELECTROMAGNETIC GUN PLANS** Projects a metal object a considerable distance-requires adult supervision £5 ref F/EML2.

**ELECTRIC MAN PLANS, SHOCK PEOPLE WITH THE TOUCH OF YOUR HAND!** £5/set Ref F/EMA1.

**PARABOLIC DISH MICROPHONE PLANS** Listen to distant sounds and voices, open windows, sound sources in 'hard to get' or hostile premises. Uses satellite technology to gather distant sounds and focus them to our ultra sensitive electronics. Plans also show an optional wireless link system. £8/set ref F/PM5

**2 FOR 1 MULTIFUNCTIONAL HIGH FREQUENCY AND HIGH DC VOLTAGE, SOLID STATE TESLA COIL AND VARIABLE 100,000 VDC OUTPUT GENERATOR PLANS** Operates on 9-12vdc, many possible experiments. £10 Ref F/HVM7/TCL4.

**WOLVERHAMPTON BRANCH**
**NOW OPEN AT WORCESTER ST**
**W'HAMPTON TEL 01902 22039**

**MINI FM TRANSMITTER KIT** Very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but easily changed to cover 63-130 Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £7 Ref 1001.

**ELECTRONIC SIREN KIT** Impressive 5 watt power output. Ideal for car/bike alarm etc. 6-12v dc max current 1A, 1.2khz £6 Ref 1003.

**3-30V POWER SUPPLY KIT** Variable, stabilized power supply for lab use. Short circuit protected, suitable for profesional or amateur use 24v 3A transformer is needed to complete the kit. £14 Ref 1007.

**1 WATT FM TRANSMITTER KIT** Supplied with piezo electric microphone 8-30vdc. At 25-30v you will get nearly 2 watts! £12 ref 1009.

**FM/AM SCANNER KIT** Well not quite, you have to turn the knob your self but you will hear things on this radio that you would not hear on an ordinary radio (even TV). Covers 50-160mhz on both AM and FM. Built in 5 watt amplifier, inc speaker. £15 ref 1013.

**MOSQUITO REPELLER KIT** Modern way to keep midges at bay! Runs for about a month on one 1.5v battery. £7 Ref 1015.

**3 CHANNEL SOUND TO LIGHT KIT** Wireless system, mains operated, separate sensitivity adjustment for each channel, 1,200 w power handling, microphone included. £14 Ref 1014.

**MOTORBIKE/CYCLE TREMBLER ALARM KIT** Adjustable sensitivity, preset alarm time, auto reset. Could be connected to horn etc. £12 Ref 1011.

**0-5 MINUTE TIMER KIT** adjustable, will switch up to 2A mains. Perfect for alarms, photography, etc. £7 Ref 1020.

**4 WATT FM TRANSMITTER KIT** Small but powerful FM transmitter, 3 RF stages, microphone and audio preamp included. £20 Ref 1028.

**STROBE LIGHT KIT** Adjustable from 1-60 hz (a lot faster than conventional strobes). Mains operated. £16 Ref 1037.

**ULTRASONIC RADAR KIT** Ideal as a movement detector with a range of about 10 metres, automate your cat flap! 12v dc. £15 Ref 1049.

**LIQUID LEVEL DETECTOR KIT** Useful for tanks, ponds, baths, rain alarm, leak detector etc. Will switch 2A mains. £5 Ref 1081.

**COMBINATION LOCK KIT** 9 key, programmable, complete with keypad, will switch 2A mains. 9v dc operation. £10 ref 1114.

**PHONE BUG DETECTOR KIT** This device will warn you if somebody is eavesdropping on your line. £6 ref 1130.

**ROBOT VOICE KIT** Interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £9 ref 1131

**TELEPHONE BUG KIT** Small bug powered by the 'phone line, starts transmitting as soon as the phone is picked up! £8 Ref 1135.

**FUNCTION GENERATOR KIT** Produces sinusoidal, saw tooth and square waves from 20-20khz, separate level controls for each shape. Will produce all 3 together. 24vac. £16 ref 1008.

**3 CHANNEL LIGHT CHASER KIT** 800 watts per channel, speed and direction controlssupplied with 12 LEDS (you can fit triacs instead to make kit mains, not supplied) 9-12vdc £17 ref 1026.

**12V FLOURESCENT LAMP DRIVER KIT** Light up 4 foot tubes from your car battery! 9v 2a transformer also required. £8 ref 1069.

**VOXSWITCH KIT** Sound activated switch ideal for making bugging tape recorders etc, adjustable sensitivity. £8 ref 1073.

**INCAR SOUND TO LIGHT KIT** Put some atmosphere in your car with this mini 3 channel sound to light. Each channel has 6 led's. £10 ref 1086.

**7W HI FI AMPLIFIER KIT** Useful, powerful, ideal for audio systems, intercoms etc. 12-18vdc £7 ref 1025.

**Check out our**
**WEB SITE**

**http://www.pavilion.co.uk/bull-electrical**

**PREAMP MIXER KIT** 3 input mono mixer, sep bass and treble controls plus individual level controls, 18vdc, input sens 100mA. £15 ref 1052.

**METAL DETECTOR KIT** Range 15-20cm, complete with case, 9vdc. £8 ref 1022.

**SINGLE CHANNEL SOUND TO LIGHT KIT** Mains operated, add rythum to your party for only £8 ref 1006.

**SOUND EFFECTS GENERATOR KIT** Produces sounds ranging from bird chips to sirens. Complete with speaker, add sound effects to your projects for just £9 ref 1045.

**GUITAR PREAMP KIT** Complete with tone controls, small enough to fit in any guitar, based on TL082 IC, 9-12vdc £8 Ref 1091.

**15 WATT FM TRANSMITTER (BUILT)** 4 stage high power, preamp required 12-18vdc, can use ground plane, yagi or open dipole. £69 ref 1021.

**TELEPHONE AMPLIFIER KIT** Very sensitive amplifier which uses a pickup coil (supplied) will let you follow a conversation with out holding the 'phone. £11 ref 1059.

**HUMIDITY METER KIT** Builds into a precision LCD humidity meter, 9 ic design, pcb, lcd display and all components included. £49

*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

**BULL ELECTRICAL**
**250 PORTLAND ROAD, HOVE, SUSSEX .**
**BN3 5QT. (ESTABLISHED 50 YEARS).**
**MAIL ORDER TERMS: CASH, PO OR CHEQUE**
**WITH ORDER PLUS £3 P&P PLUS VAT.**
PLEASE ALLOW 7-10 DAYS FOR DELIVERYPHONE ORDERS
WELCOME (ACCESS,VISA, SWITCH, AMERICAN EXPRESS)
**TEL: 01273 203500**
**FAX 01273 323077**
**E-mail bull@pavilion.co.uk**

**PC TIMER KIT** Four channel output controlled by your PC, will switch high current mains with relays (supplied). Software supplied so you can program the channels to do what you want whenever you want. Minimum system configeration is 286, VGA, 4.1,640k, serial port, hard drive with min 100k free. £24.99

**DIVINING RODS** Expensive technology cannot challenge the fool proof art of water divining, passed down from generation to generation. Seeing is believing. Use in the home, garden, countryside or desert, it's divinely simple! £4.99 a pair ref E/3.

**HUGE BUBBLE MAKING KIT** You'll be amazed at the the size of the bubbles you can acheive with this bubble making kit. Once you have got the knack it is possible to make bubbles of up to 40 feet long. £11.99 ref E/9.

**FM CORDLESS MICROPHONE** This unit is an FM broadcasting station in minature, 3 transistor transmitter with electret condenser mic+fet amp design result in maximum sensitivity and broad frequency response. 90-105mhz, 50-1500hz, 500 foot range in open country! PP3 battery required. £15.00 ref 15P42A.

**MAGNETIC MARBLES** They have been around for a number of years but still give rise to curiosity and amazement. A pack of 12 is just £3.99 ref GI/R20

**STETHOSCOPES** A fully functioning stethoscope for all those intricate projects. Enables you to listen to motors, pipes, heartbeats, walls, insects etc. £6 ref MAR6P6.

**NICKEL PLATING KIT** Proffesional electroplating kit that will transform rusting parts into showpieces in 3 hours! Will plate onto steel, iron, bronze, gunmetal, copper, welded, silver soldered or brazed joints. Kit includes enough to plate 1,000 sq inches. You will also need a 12v supply, a container and 2 12v light bulbs. £39.99 ref NIK39.

**SHOP WOBBLERS!** Small assemblies designed to take D size batteries and 'wobble' signs about in shops! £3.99 Ref SEP4P2.

**OMRON ELECTRONIC INTERVAL TIMERS.**

*******NEW LOW PRICES TO CLEAR!!!********

**Minature adjustable timers, 4 pole c/o output 3A 240v,**
HY1230S, 12vDC adjustable from 0-30 secs. £4.99
HY1210M, 12vDC adjustable from 0-10 mins. £4.99
HY1260M, 12vDC adjustable from 0-60 mins. £4.99
HY2460M, 24vAC adjustable from 0-60 mins. £2.99
HY243H, 24vAC adjustable from 0-3 hours. £2.99
HY2401S, 240v adjustable from 0-1 secs. £4.99
HY2405S, 240v adjustable from 0-5 secs. £4.99
HY24060m, 240v adjustable from 0-60 mins. £6.99

**DRINKING BIRD** Remember these? hook onto wine glass (supplied) and they drink, standup, drink, standup ETC! £4 each Ref EF1

**SOLAR POWER LAB SPECIAL** You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor. Superb value kit just £5.99 REF: MAG6P8

**BUGGING TAPE RECORDER** Small voice activated recorder, uses micro cassette complete with headphones. £28.99 ref MAR29P1.

**PLUG IN ACORN PSU** 19v AC 14w , £2.99 REF MAG3P10

**POWER SUPPLY** fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

**9v DC POWER SUPPLY** Standard plug in type 150ma 9v DC with lead and DC power plug. price for two is £2.99 ref AUG3P4.

**13.8V 1.9A** psu cased with leads. Just £9.99 REF MAG10P3

**INFRA RED REMOTE CONTROLLERS** Originally made for hi spec satellite equipment but perfect for all sorts of remote control projects. Our clearance price is just £2 **REF: MAG2**

**MAINSCABLE** Precut black 2 core 2 metre lengths ideal for repairs, projects etc. 50 metres for £1.99 ref AUG2P7.

**COMPOSITE VIDEO KIT.** Converts composite video into separate H sync, V sync, and video. 12v DC. £8.00 **REF: MAG8P2.**

**UNIVERSAL PC POWER SUPPLY** complete with flyleads, switch, fan etc.200w at £20 REF: MAG20P3 (265x155x125mm).

**GYROSCOPE** About 3" high and an excellent educational toy for all ages! Price with instruction booklet £6 Ref EF15.

**FUTURE PC POWER SUPPLIES** These are 295x135x60mm, 4 drive connectors 1 mother board connector. 150watt, 12v fan, iec inlet and on/off switch. £12 Ref EF6.

**VENUS FLYTRAP KIT** Grow your own carnivorous plant with this simple kit £3 ref EF34.

**TWEETERS** 2" diameter good quality tweeter 140R (ok with the above speaker) 2 for £2 **REF: MAG2P5** or 4 for £3 **REF: MAG3P4**

**6"X12" AMORPHOUS SOLAR PANEL** 12v 155x310mm 130mA. Bargain price just £5.99 ea REF MAG6P12.

**FIBRE OPTIC CABLE BUMPER PACK** 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

**ROCK LIGHTS** Unusual things these, two pieces of rock that glow when rubbed together! belived to cause rain!£3 a pair Ref EF29.

**3' by 1' AMORPHOUS SOLAR PANELS** 14.5v, 700mA 10 watts, aluminium frame, screw terminals, £44.95 ref MAG45.

**ELECTRONIC ACCUPUNCTURE KIT** Builds into an electronic version instead of needles! good to experiment with. £7 ref 7P30

**SHOCKING COIL KIT** Build this little battery operated device into all sorts of things, also gets worms out of the ground! £7 ref 7P36.

**FLYING PARROTS** Easily assembled kit that builds a parrot that actually flaps its wings and flies! 50 m range £6 ref EF2.

**HIGH POWER CATAPULTS** Hinged arm brace for stability, tempered steel yoke, super strength latex power bands. Departure speed of ammunition is in excess of 200 miles per hour! Range of over 200 metres! £7.99 ref R/9.

**BALLON MANUFACTURING KIT** British made, small blob blows into a large, longlasting balloon, hours of fun! £3.99 ref GI/E99R

---

**WE BUY SURPLUS STOCK FOR CASH**

---

## FREE CATALOGUE

**100 PAGE CATALOGUE NOW AVAILABLE, 45P STAMP OR FREE ON REQUEST WITH ORDER.**

# WINTER 1995/6 CATALOGUE

£1.95
electronic constructors catalogue
Cirkit
components ▶ test equipment ▶ kits
EXTRA £60 Worth Discount Vouchers!
WIN!
A Hameg 30MHz Oscilloscope
FREE competition see page 6
NEW IN THIS ISSUE:
COMPUTER EQUIPMENT AND ACCESSORIES AT UNBEATABLE PRICES
70cm NOVICE TRANSCEIVER
LOW COST PIC PROGRAMMERS AND ICs
Winter 95/96
ISSN 0955-1100

**The new winter '95/96 edition has 280 pages packed with over 4000 products.**

- New editions to our computer section further extending our range of PC components and accessories at unbeatable prices
- Free competition with a chance of winning a Hameg 30MHz oscilloscope
- 100's of new products including; Books, Component Packs, Connectors, Switches, Test Equipment and Tools.
- New range of oscilloscopes from Hameg and extended range of mobile phone batteries and accessories
- Latest PIC Microcontroller IC's and programmer
- New 70cms mobile transceiver for the novice radio amateur enthusiast
- 280 pages, 26 sections and over 4000 products from some of the worlds finest suppliers
- Available at most newsagents or direct from Cirkit
- **Send for your copy today!**

**£1.95**
+ 30p p&p

Cirkit

Access

VISA

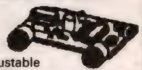
**Cirkit Distribution Ltd**
Park Lane · Broxbourne · Hertfordshire · EN10 7NQ
Telephone: 01992 448899 · Fax: 01992 471314

QUASAR Electronics

# QUASAR ELECTRONICS

## SECURITY

**ULTRASONIC MOVEMENT DETECTOR**



Xtal controlled oscillator, detector circuits & edge mounted transducers on one PCB just 75x40mm. Detection range 4-7m. Adjustable sensitivity. LED indicator. Outputs to drive external relay/circuits. 9V DC operation. *3049-KT.* ***£14.95***

## CCD CAMERA

Latest high quality low-light, IR-sensitive camera module from KOCOM # CA-H34C for Video Intercom CCTV, Surveillance etc. Six IR LED's on board allow camera to 'see' in the dark. Half the size of a cigarette packet!

*ASSEMBLED UNIT:*
*30A7-AS £89.95*

FEATURES
- Compact & light camera PCB module. 54x38mm.
- Low power consumption
- Low illumination requirements (0.1Lux)
- High quality, high resolution image
- Maintenance free
- Built-in electronically controlled auto-iris
- Internal synchronisation

## REPORTS & PLANS

N.B. MINIMUM ORDER CHARGE FOR PLANS AND REPORTS IS £5.00 PLUS NORMAL P.&P.

**TELEPHONE BUG DETECTION** Why spend a fortune on expensive bug detection equipment when you can Do-it-Yourself for next to nothing. All you need to know is in this easy to understand report. *R001* ***£2.00***

**SUPER-EAR LISTENING DEVICE** Complete plans to build your own parabolic dish microphone. Listen to distant voices and sounds through open windows and even walls! Made from readily available parts. *R002* ***£3.50***

**TELEPHONE BUG PLANS** Build you own micro-beetle telephone bug. Suitable for any phone. Transmits over 250 metres – more with good receiver. Made from easy to obtain, cheap components. *R006* ***£3.00***

**RADIO & TV JOKER PLANS** We show you how to build three different circuits for disrupting TV picture and sound plus FM radio! May upset your neighbours & the authorities!! DISCRETION REQUIRED. *R017* ***£3.50***

**INFINITY TRANSMITTER PLANS** Complete plans for building the famous Infinity Transmitter. Once installed on the target phone, device acts like a room bug. Just call the target phone & activate the unit to hear all room sounds. Great for home/office security! *R019* ***£3.00***

**THE ETHER BOX CALL INTERCEPTOR PLANS** Grabs telephone calls out of thin air! No need to wire-in a phone bug. Simply place this device near the phone lines to hear the conversations taking place! *R025* ***£3.00***

Full details of our complete range of Reports & Plans can be found in our Main catalogue.

## GENERAL KITS

**3 DIGIT LED COUNTER** 2 board basic event counter. Main board has 3 digit counter circuit. 2nd board has Count & Reset switches & debounce circuit. Cascaded with other boards to provide more digits. Box & battery holder provided. 9V battery. 78x50x25mm. *3001-KT.* ***£14.95***

**LED SEQUENCE FLASHER** 5 red LED's flash in sequence. Ideal for model railways. On/off switch. COB PCB 15x8mm (spare provided). 3V powered. *3052-KT.* ***£3.95***

**OP-AMP FUNCTION GENERATOR** Quad Op-Amp connected as oscillator & wave shapers to generate audio range wave-forms. Oscillator generates Square Wave from 6Hz to 6KHz. Other amps produce Triangle & pseudo Sine outputs. Solder pad outputs. 9V powered. 47x40x22mm. *3023-KT.* ***£4.95***

**LOGIC PROBE** Original, modern design tests both CMOS & TTL circuits as well as detecting fast pulses. Gives visual & audio indication of logic states found. Powered from circuit under test. It's operation is fully explained. *3024-KT.* ***£7.95***

**ROULETTE LED** A great introduction to gambling..... err electronics! Watch the 'ball' spin round the roulette wheel, slow down & drop into slot. Uses 10 LED's, CMOS decade counter & Op-Amp to teach Voltage Controlled Oscillator (VCO) principles. 9V powered. Educational & fun!! *3006-KT.* ***£10.95***

**PELTIER JUNCTION HEAT PUMP** Boil or freeze water instantly! Use for regulated cooling of temperature sensitive components and much more. *3066-KT.* ***£21.95***

**9V XENON TUBE FLASHER** This powerful high voltage xenon flasher runs off a simple 9V battery. A transformer is used to step up the 9V supply voltage to the high voltage required to flash the 25mm long tube. Flash rate adjustable between 0.25 to 2 second intervals. *3022-KT.* ***£11.95***

**LM383 AMPLIFIER MODULE** Proven, popular building block for use in any audio project where general amplification required. Power output dependent on supply voltage & load resistance. Typical ratings: Over 10W for 16V supply & 2W speaker; 1W for 9V supply & 8W speaker. *3047-KT.* ***£9.95***

**COMBINATION LOCK** Versatile electronic lock comprising main circuit & separate 9 key touch-pad for remote opening of lock. 120VAC/10A relay supplied. 9-12V. *3029-KT.* ***£9.95***

**LIGHT ALARM** Protect your valuables with this practical, clever little circuit. Alarm sounds if even the smallest amount of light falls on the circuit. Place in cash box etc. *3008-KT.* ***£4.95***

**THE SCREAMER!** Frighten the life out of any unsuspecting/unwanted guests! Painful alarm siren gives out a massive 110db of ear piercing noise. Box supplied has two 35mm piezo elements already built into their own resonant cavity. PCB also fits inside box to give a neat, compact unit. Can be used as part of an alarm circuit or just for the fun of it!! 6-9V operation. *3015-KT* ***£9.95***

## SURVEILLANCE

*High performance surveillance kits. Room transmitters supplied with sensitive electret microphones & battery holders/clips. All transmitters can be received on an ordinary VHF FM radio.*

**MTX - Miniature 3V Transmitter**
Easy to build & guaranteed to transmit 500 metres (over 1000m possible with higher voltage & better aerial). 3-9V operation. Only 45x18mm. *3007-KT.* ***£5.50***

**MRTX - Miniature 9V Room Transmitter**
Our best selling 'bug'. Super sensitive, high power - 1000m range (Up to 2 miles with 18V supply & better aerial!). 9V operation. 45x19mm. *3018-KT.* ***£6.50***

**HPTX - High Power Room Transmitter**
High performance, 2 stage transmitter gives greater stability & high quality reception. 1000m range with 9V battery. 6-12V operation. On/ off switch. Size 70x15mm. *3032-KT.* ***£7.50***

**VTX - Voice Activated Transmitter**
Activates only when sounds are detected. Low standby current conserves battery power. Adjustable sensitivity & turn-off delay. 6V operation. Size 63x38mm. Powerful 2 stage transmitter. 1000m range. *3028-KT.* ***£9.50***

**TRI - Telephone Recording Interface**
Connect between phone line & cassette recorder. Automatic-ally switches on tape when phone is used. Records all conversations. Powered from line. 48x32mm. *3033-KT.* ***£6.50***

**TRVS - Tape Recorder Vox Switch**
Very sensitive, voice activated switch - automatically turns on cassette recorder when sounds are detected. Adjustable sensitivity & turn-off delay. 115x19mm inc. mic. *3013-KT.* ***£7.50***

**MTTX - Miniature Telephone Transmitter**
Attaches anywhere to phone line. Transmits only when phone is used! Uses phone line as aerial & power source. 500m range. 45x15mm. *3016-KT.* ***£5.50***

**Two Station Intercom/Hard Wired Bug**
Simple two wire intercom/hard wired bug. Each unit has its own speaker, microphone & amplifier (LM386). Can be modified to a hard wired 'bug' by using 4 strand ribbon cable to send power from the receiving unit to the remote 'bug' unit. 9V operation. *3021-KT.* ***£12.95***

**Telephone Amplifier Kit**
Pick-up coil & sensitive amplifier let you hear conversations without even holding the phone! Can be used for surveillance purposes. *3055-KT.* ***£9.95***

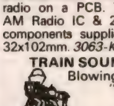
**LED DICE** The classic electronic project that never loses it's popularity. Combines a great game with an easy introduction to electronics & simple circuit analysis. 7 LED's simulate a real dice face. The dice rolls, slows down, stops on a number at random. Uses a 555 timer & counter IC. Box included. 9V operation. *3003-KT.* ***£8.95***

**STAIRWAY TO HEAVEN GAME** This game of skill tests your hand-eye co-ordination. If you press the switch each time the green part of the bi-polar LED lights you climb higher up the stairway - but miss & you start again! Introduces you to several basic electronic circuits. Box provided. 9V operation. 78x50x19mm. Rolfe Harris NOT included! *3005-KT.* ***£8.95***

**DC MOTOR SPEED CONTROLLER** Control the speed of any common DC motor rated up to 100V (5A). Operates on 5-15V. Uses NE556 IC to pulse-width modulate a TIP122 high current, switching power transistor. In this way torque of the motor is not lowered. Box mounted. *3067-KT.* ***£19.95***

**SWITCHING POWER SUPPLY** Replace expensive 9V batteries with cost-efficient 1.5V cells. IC based circuit acts as a step-up switching power supply. Selectable 1.5 or 3V DC inputs. Gives a fixed output of 9V @ 18mA from a 1.5V "AA" cell. Solder pads for input/output. 1 cell & 2 cell "AA" holders & jumper switches supplied. 40x15x12mm. *3035-KT.* ***£4.95***

**SINGLE CHIP AM RADIO** Complete mini sized AM radio on a PCB. Tuned Radio Frequency front-end, AM Radio IC & 2 stages of audio amplification. All components supplied inc. prewound coil & speaker. 32x102mm. *3063-KT.* ***£9.95***



**TRAIN SOUNDS** 4 selectable sounds - Whistle Blowing, Level Crossing Bell, Chugging & "Clickety-Clack". 2.5-6V. Supplied with all components inc. speaker, 16 x 29mm COB PCB, switches & 2 x "AA" battery holders. *SG1.* ***£4.95***

**plus AUDIO • EDUCATIONAL • LASER • SECURITY • TEST GEAR • BOOKS & more**

All kits are high quality projects supplied with all components, fibre glass PCB's & comprehensive instructions. **FREE CATALOGUE** with order or send 2 x 1st Class stamps (refundable) for details of over 100 kits & publications. Mail order only. Please **ADD £2.00 P. & P.** per order & make cheques/PO's payable to **Quasar Electronics.** All prices include VAT at 17·5%. Goods normally despatch within 5 working days but please allow 28 days for delivery.

**Unit 14 Sunnningdale BISHOP'S STORTFORD Herts CM23 2PA**
**E-mail: 101364.3510 @compuserve.com**

# DIRECT BOOK SERVICE

### ELECTRONICS TEACH-IN 88/89 INTRODUCING MICROPROCESSORS
**Mike Tooley B.A. (published by *Everyday Practical Electronics*)**

A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.

Sections cover Microcomputer Systems, Microprocessors, Memories, Input/Output, Interfacing and Programming. There are various practical assignments and eight Data Pages covering popular microprocessors.

And excellent introduction to the subject even for those who do not wish to take the City and Guilds assessment.

*80 pages* Order code TI-88/89 **£2.45**

### ELECTRONICS TEACH-IN No.6 DESIGN YOUR OWN CIRCUITS
**(published by *Everyday Practical Electronics*)**
**Mike Tooley B.A.**

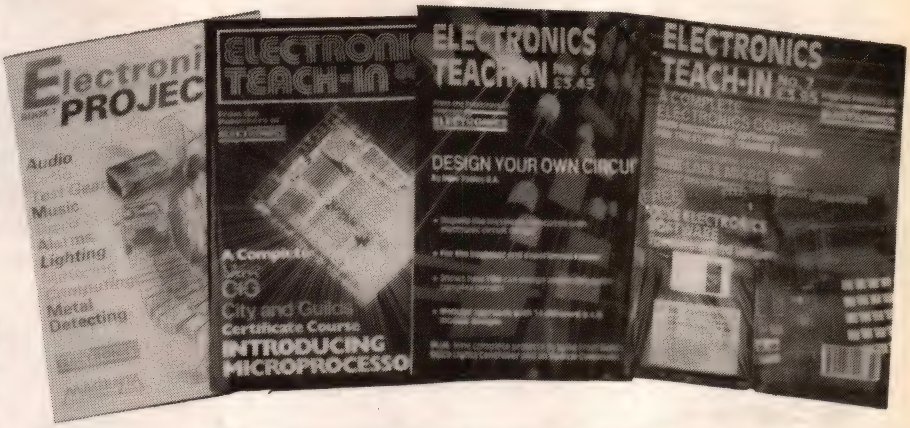
This book is designed for the beginner and experienced reader alike, and aims to dispel some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits.

Fourteen individual p.c.b. modules are described which, with various detailed modifications, should allow anyone to design and construct a very wide range of different projects. Nine "hands-on" complete DIY projects have also been included so readers can follow the thinking behind design, assembly, construction, testing and evaluation, together with suggested "mods" to meet individual needs.

The subjects covered in each chapter of the book are: Introduction and Power Supplies; Small Signal Amplifiers; Power Amplifiers; Oscillators; Logic Circuits; Timers; Radio; Power Control; Optoelectronics.

The nine complete constructional projects are: Versatile Bench Power Supply; Simple Intercom; Bench Amplifier/Signal Tracer; Waveform Generator; Electronic Die; Pulse Generator; Radio Receiver; Disco Lights Controller; Optical Communications Link.

*136 pages* Order code TI6 **£3.45**


Electronic PROJECTS
ELECTRONICS TEACH-IN
A Complete City and Guilds Certificate Course INTRODUCING MICROPROCESSORS
ELECTRONICS TEACH-IN No 6
DESIGN YOUR OWN CIRCUITS
ELECTRONICS TEACH-IN No 7

**The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order to your door. Full ordering details are given on the last book page.**

**For another selection of books see next month's issue.**

**Note our UK postage costs just £1.50 no matter how many books you order!**

### TEACH-IN No. 7. plus FREE SOFTWARE ANALOGUE AND DIGITAL ELECTRONICS COURSE
**(published by *Everyday Practical Electronics*)**
**Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE**

This highly acclaimed *EPE Teach-In series, which included the construction and use of the Mini Lab* and *Micro Lab* test and development units, has been put together in book form. Additionally, EPT Educational Software have developed a GCSE Electronics software program to compliment the course and a **FREE DISKC** covering the first two parts of the course is included with the book.

An interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles.

If you are taking electronics or technology at school or college, this book is for you. If you just want to learn the basics of electronics or technology you must make sure you see it. *Teach-In No. 7* will be invaluable if you are considering a career in electronics or even if you are already training in one. The Mini Lab and software enable the construction and testing of both demonstration and development circuits. These learning aids bring electronics to life in an enjoyable and interesting way: you will both see and hear the electron in action! The Micro Lab microprocessor add-on system will appeal to higher level students and those developing microprocessor projects.

*160 pages* Order code TI7 **£3.95**

### ELECTRONIC PROJECTS BOOK 1
**(published by *Everyday Practical Electronics* in association with Magenta Electronics)**

Contains twenty projects from previous issues of *EE* each backed with a kit of components. The projects are: Seashell Sea Synthesizer, EE Treasure Hunter, Mini Strobe. Digital Capacitance Meter, Three-Channel Sound to Light, BBC 16K sideways RAM, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser, Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

*128 pages* Order code EP1 **£2.45**

## PROJECT CONSTRUCTION

### TEST EQUIPMENT CONSTRUCTION
**R. A. Penfold**

This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.

The following designs are included:–
AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Mullivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe.

The designs are suitable for both newcomers and more experienced hobbyists.

*104 pages* Order code BP248 **£2.95**

### HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
**R. A. Penfold**

Deals with the simple methods of copying printed circuit board designs from magazines and books, and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

*80 pages* Order code BP121 **£2.50**

### AUDIO AMPLIFIER CONSTRUCTION
**R. A. Penfold**

The purpose of this book is to provide the reader with a wide range of preamplifier and power amplifier designs that will, it is hoped, cover most normal requirements.

The preamplifier circuits include low noise microphone and RIAA types, a tape head preamplifier, a guitar preamplifier and various tone controls. The power amplifier designs range from low power battery operation to 100W MOSFET types and also include a 12 volt bridge amplifier capable of giving up to 18W output.

All the circuits are relatively easy to construct using the p.c.b. or stripboard designs given. Where necessary any setting-up procedures are described, but in most cases no setting-up or test gear is required in order to successfully complete the project.

*100 pages* Order code BP122 **£2.95**

### DESIGN YOUR OWN CIRCUITS
See ELECTRONICS TEACH IN No. 6 above left.

## RADIO / TV / VIDEO

### ELECTRONIC PROJECTS FOR VIDEO ENTHUSIASTS
**R. A. Penfold**

This book provides a number of practical designs for video accessories that will help you get the best results from your camcorder and VCR. All the projects use inexpensive components that are readily available, and they are easy to construct. Full construction details are provided, including stripboard layouts and wiring diagrams. Where appropriate, simple setting up procedures are described in detail; no test equipment is needed.

The projects covered in this book include: Four channel audio mixer, Four channel stereo mixer, Dynamic noise limiter (DNL), Automatic audio fader, Video faders, Video wipers, Video crispener, Mains power supply unit.

*109 pages* Order code BP356 **£4.95**

### SETTING UP AN AMATEUR RADIO STATION
**I. D. Poole**

The aim of this book is to give guidance on the decisions which have to be made when setting up any amateur radio or short wave listening station. Often the experience which is needed is learned by one's mistakes, however, this can be expensive. To help overcome this, guidance is given on many aspects of setting up and running an efficient station. It then proceeds to the steps that need to be taken in gaining a full transmitting licence.

Topics covered include: The equipment that is needed; Setting up the shack; Which aerials to use; Methods of construction; Preparing for the licence.

An essential addition to the library of all those taking their first steps in amateur radio.

*86 pages* Order code BP300 **£3.95**

### EXPERIMENTAL ANTENNA TOPICS
**H. C. Wright**

Although nearly a century has passed since Marconi's first demonstration or radio communication, there is still research and experiment to be carried out in the field of antenna design and behaviour.

The aim of the experimenter will be to make a measurement or confirm a principle, and this can be done with relatively fragile, short-life apparatus. Because of this, devices described in this book make liberal use of cardboard, cooking foil, plastic bottles, cat food tins, etc. These materials are, in general, cheap to obtain and easily worked with simple tools, encouraging the trial-and-error philosophy which leads to innovation and discovery.

Although primarily a practical book with text closely supported by diagrams, some formulae which can be used by straightforward substitution and some simple graphs have also been included.

*72 pages* Order code BP278 **£3.50**

### 25 SIMPLE INDOOR AND WINDOW AERIALS
**E. M. Noll**

Many people live in flats and apartments or other types of accommodation where outdoor aerials are prohibited, or a lack of garden space etc. prevents aerials from being erected. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out along the skirting board of a room can produce acceptable results. However, with some additional effort and experimentation one may well be able to improve performance further.

This concise book tells the story, and shows the reader how to construct and use 25 indoor and window aerials that the author has proven to be sure performers.

Much information is also given on shortwave bands, aerial directivity, time zones, dimensions etc.

*50 pages* Order code BP136 **£1.75**

# TESTING, THEORY, DATA AND REFERENCE

### TRANSISTOR DATA TABLES

NEW

**Hans-Günther Steidle**

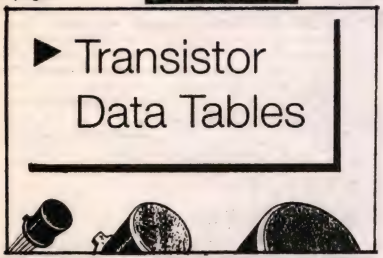
The continually growing number and variety of semiconductor components mean ever greater problems for the user. It is difficult to gain an overall picture of the types which may be suitable for a particular application, from those currently available. However, as a starting point, the electrical parameters of a device are usually sufficient.

The tables in this book contain information about the package shape, pin connections and basic electrical data for each of the many thousands of transistors listed. The data includes maximum reverse voltage, forward current and power dissipation, current gain and forward transadmittance and resistance, cut-off frequency and details of applications.

A book of this size is of necessity restricted in its scope, and the individual transistor types cannot therefore be described in the sort of detail that maybe found in some larger and considerably more expensive data books. However, the list of manufacturers' addresses will make it easier for the prospective user to obtain further information, if necessary.

Lists over 8,000 different transistors, including f.e.t.s.

*200 pages* Order code BP401 **£5.95**



### MORE ADVANCED USES OF THE MULTIMETER

**R. A. Penfold**

This book is primarily intended as a follow-up to BP239, (see below), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in Chapter 1 you can test and analyse the performance of a range of components with just a multimeter (plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.

While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in Chapter 2 extended the capabilities of a multimeter to make it even more useful.

*84 pages* Order code BP265 **£2.95**

### ELECTRONIC TEST EQUIPMENT HANDBOOK

**Steve Money**

The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of the instruments are also examined.

Everything from Audio Oscillators, through R, C & L measurements (and a whole lot more) to Waveform Generators and testing Zeners.

*206 pages* Order code PC109 **£8.95**

### A REFERENCE GUIDE TO BASIC ELECTRONICS TERMS

**F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.**

The wonders of electronics multiply unceasingly and electronic devices are creeping relentlessly into all walks of modern life. As with most professions, ours too has a language of its own, ever expanding and now encompassing several thousands of terms. This book picks out and explains some of the more important fundamental terms (over 700), making the explanations as easy to understand as can be expected of a complicated subject and avoiding high-level mathematics.

Through its system of references, each term is backed up by a list of other relevant or more fundamental terms so that a chosen subject can be studied to any depth required.

*472 pages* Order code BP286 **£5.95**

### GETTING THE MOST FROM YOUR MULTIMETER

**R. A. Penfold**

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

*96 pages* Order code BP239 **£2.95**

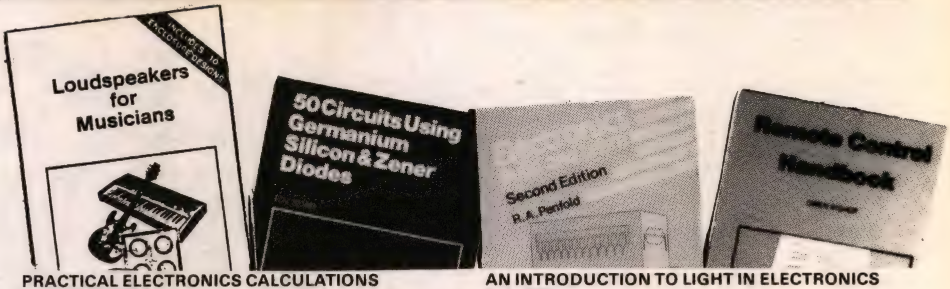
### ELECTRONICS-BUILD AND LEARN

**R. A. Penfold**

The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components – resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op.amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuit you build.

*120 pages* Order code PC103 **£6.95**


Loudspeakers for Musicians
INCLUDES 10 ENCLOSURE DESIGNS
50 Circuits Using Germanium Silicon & Zener Diodes
Second Edition
R. A. Penfold
Remote Control Handbook

### PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE

**F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.**

Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias – tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-Current Circuits, Passive Components, Alternating-Current Circuits, Networks and Theorems, Measurements.

*256 pages* Order code BP53 **£3.95**

### NEWNES ELECTRONICS TOOLKIT

**Geoff Phillips**

The author has used his 30 years experience in industry to draw together the basic information that is constantly demanded. Facts, formulae, data and charts are presented to help the engineer when designing, developing, evaluating, fault finding and repairing electronic circuits. The result is this handy workmate volume: a memory aid, tutor and reference source which is recommended to all electronics engineers, students and technicians.

Have you ever wished for a concise and comprehensive guide to electronics concepts and rules of thumb? Have you ever been unable to source a component, or choose between two alternatives for a particular application? How much time do you spend searching for basic facts or manufacturer's specifications? This book is the answer, it covers resistors, capacitors, inductors, semiconductors, logic circuits, EMC, audio, electronics and music, telephones, electronics in lighting, thermal considerations, connections, reference data.

*158 pages* Order code NE20 **£12.95**

### INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE

**A. Michaels**

Helps the reader to find possible substitutes for a popular selection of European. American and Japanese transistors. Also shows material type, polarity, manufacturer and use.

*320 pages* Order code BP85 **£3.95**

### AN INTRODUCTION TO LIGHT IN ELECTRONICS

**F. A. Wilson**

Marconi first bridged the Atlantic with radio waves, then of a mere 200 kilohertz. Since then for communication we have moved up the frequency scale through megahertz and microwaves and are now probing light waves. Accordingly no self-respecting electronics engineer can afford not to be conversant with light and its uses in electronics since development of opto-electronic devices and communication systems is proceeding at a truly explosive rate.

This book is not for the expert but neither is it for the completely uninitiated. It is assumed the reader has some basic knowledge of electronics. After dealing with subjects like Fundamamentals, Waves and Particles and The Nature of Light such things as Emitters, Detectors and Displays are discussed. Chapter 7 details four different types of Lasers before concluding with a chapter on Fibre Optics.

*161 pages* Order code BP359 **£4.95**

### PRACTICAL ELECTRONIC DESIGN DATA

**Owen Bishop**

This book is a comprehensive ready-reference manual for electronics enthusiasts of all levels, be they hobbyists, students or professionals. A helpful major section covers the main kinds of component, including surface-mounted devices. For each sort, it lists the most useful and readily available types, complete with details of their electronic characteristics, pin-outs and other essential information.

Basic electronic units are defined, backed up by a compendium of, the most often required formulae, fully explained. There are five more extensive sections devoted to circuit design, covering analogue, digital, radio, display, and power supply circuits. Over 150 practical circuit diagrams cover a broad range of functions. The reader is shown how to adapt these basic designs to a variety of applications. Many of the circuit descriptions include step-by-step instructions for using most of the standard types of integrated circuit such as operational amplifiers, comparators, filters, voltage converters and switched-mode power supply devices, as well as the principal logic circuits.

*328 pages* **Temporarily out of print**

# AUDIO AND MUSIC

### INTRODUCTION TO DIGITAL AUDIO (Second Edition)

**Ian Sinclair**

Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.

All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.

This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product.

*128 pages* Order code PC102 **£7.95**

### AUDIO

**F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.**

Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems – amplifiers, oscillators, disc and magnetic recording and electronic music.

*320 pages* Order code BP111 **£3.95**

### PROJECTS FOR THE ELECTRIC GUITAR

**J. Chatwin**

This book is for anyone interested in the electric guitar. It explains how the electronic functions of the instrument work together, and includes information on the various pickups and transducers that can be fitted. There are complete circuit diagrams for the major types of instrument, as well as a selection of wiring modifications and pickup switching circuits. These can be used to help you create your own custom wiring.

Along with the electric guitar, sections are also included relating to acoustic instruments. The function of specialised piezoelectric pickups is explained and there are detailed instructions on how to make your own contact and bridge transducers. The projects range from simple preamps and tone boosters, to complete active controls and equaliser units.

*92 pages* Order code BP358 **£4.95**

### MIDI SURVIVAL GUIDE

**Vic Lennard**

Whether you're a beginner or a seasoned pro, the MIDI Survival Guide shows you the way. No maths, no MIDI theory, just practical advice on starting up, setting up and ending up with a working MIDI system.

Over 40 cabling diagrams. Connect synths, sound modules, sequencers, drum machines and multitracks. How to budget and buy secondhand. Using switch, thru and merger boxes. Transfer songs between different sequencers. Get the best out of General MIDI. Understand MIDI implementation charts. No MIDI theory.

*104 pages* Order code PC111 **£6.95**

### PRACTICAL ELECTRONIC MUSICAL EFFECTS UNITS

**R. A. Penfold**

This book provides practical circuits for a number of electronic musical effects units. All can be built at relatively low cost, and use standard, readily available components. The projects covered include: Waa-Waa Units; Distortion Units; Phaser; Guitar Envelope Shaper; Compressor; Tremolo Unit; Metal Effects Unit; Bass and Treble Boosters; Graphic Equaliser; Parametric Equaliser. The projects cover a range of complexities, but most are well within the capabilities of the average electronics hobbyist. None of them require the use of test equipment and several are suitable for near beginners.

*102 pages* Order code BP368 **£4.95**

### LOUDSPEAKERS FOR MUSICIANS

**Vivan Capel**

This book contains all that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, when and where to use wadding, and when not to, what fittings are available, finishing, how to ensure they travel well, how to connect multi-speaker arrays and much more.

Ten practical enclosure designs with plans and comments are given in the last chapter, but by the time you've read that far you should be able to design your own!

*164 pages* Order code BP297 **£3.95**

# CIRCUITS AND DESIGN

### REMOTE CONTROL HANDBOOK (Revised Edition)
**Owen Bishop**

Remote control systems lend themselves to a modular approach. This makes it possible for a wide range of systems, from the simplest to the most complex, to be built up from a number of relatively simple modules. The author has tried to ensure that, as far as possible, the circuit modules in this book are compatible with one another. They can be linked together in many different configurations to produce remote control systems tailored to switch a table lamp on and off, or to operate an industrial robot, this book should provide the circuit you require.

*240 pages* **Order code BP240** **£3.95**

### COIL DESIGN AND CONSTRUCTIONAL MANUAL
**B. B. Babani**

A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now twenty years old, with the exception of toroids and pulse transformers little has changed in coil design since it was written.

*96 pages* **Order code 160** **£2.50**

### PRACTICAL ELECTRONICS HANDBOOK – Fourth Edition. Ian Sinclair

Contains all of the everyday information that anyone working in electronics will need.

It provides a practical and comprehensive collection of circuits, rules of thumb and design data for professional engineers, students and enthusaists, and therefore enough background to allow the understanding and development of a range of basic circuits.

Contents: Passive components, Active discrete components, Discrete component circuits, Sensing components, Linear I.C.s, Digital I.C.s, Microprocessors and microprocessor systems, Transferring digital data, Digital-analogue conversions, Computer aids in electronics, Hardware components and practical work, Standard metric wire table, Bibliography, The HEX scale, Index.

*440 pages* **Order code NE21** **£12.99**

### AUDIO IC CIRCUITS MANUAL
**R. M. Marston**

A vast range of audio and audio-associated i.c.s are readily available for use by amateur and professional design engineers and technicians. This manual is a guide to the most popular and useful of these devices, with over 240 diagrams. It deals with i.c.s such as low frequency linear amplifiers, dual pre-amplifiers, audio power amplifiers, charge coupled device delay lines, bar-graph display drivers, and power supply regulators, and shows how to use these devices in circuits ranging from simple signal conditioners and filters to complex graphic equalizers, stereo amplifier systems, and echo/reverb delay lines etc.

*168 pages* **Temporarily out of print**

### 50 CIRCUITS USING GERMANIUM, SILICON AND ZENER DIODES
**R. N. Soar**

Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most simple and inexpensive of components – the diode. Includes the use of germanium and silicon signal diodes, silicon rectifier diodes and Zener diodes, etc.

*64 pages* **Order code BP36** **£1.95**

### A BEGINNERS GUIDE TO CMOS DIGITAL ICs
**R. A. Penfold**

Getting started with logic circuits can be difficult, since many of the fundamental concepts of digital design tend to seem rather abstract, and remote from obviously useful applications. This book covers the basic theory of digital electronics and the use of CMOS integrated circuits, but does not lose sight of the fact that digital electronics has numerous "real world" applications.

The topics covered in this book include: the basic concepts of logic circuits; the functions of gates, inverters and other logic "building blocks"; CMOS logic i.c. characteristics, and their advantages in practical circuit design; oscillators and monostables (timers); flip/flops, binary dividers and binary counters; decade counters and display drivers.

The emphasis is on a practical treatment of the subject, and all the circuits are based on "real" CMOS devices. A number of the circuits demonstrate the use of CMOS logic i.c.s in practical applications.

*119 pages* **Order code BP333** **£4.95**

### OPTOELECTRONICS CIRCUITS MANUAL
**R. M. Marston**

A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s and other devices used are inexpensive and readily available types, with universally recognised type numbers.

*182 pages* **Order code NE14** **£13.95**

### OPERATIONAL AMPLIFIER USER'S HANDBOOK
**R. A. Penfold**

The first part of this book covers standard operational amplifer based "building blocks" (integrator, precision rectifier, function generator, amplifiers, etc), and considers the ways in which modern devices can be used to give superior performance in each one. The second part describes a number of practical circuits that exploit modern operational amplifiers, such as high slew-rate, ultra low noise, and low input offset devices. The projects include: Low noise tape preamplifier, low noise RIAA preamplifier, audio power amplifiers, d.c. power controllers, opto-isolator audio link, audio millivolt meter, temperature monitor, low distortion audio signal generator, simple video fader, and many more.

*120 pages* **Order code BP335** **£4.95**

### TIMER/GENERATOR CIRCUITS MANUAL
**R. M. Marston**

This manual is concerned mainly with waveform generator techniques and circuits. Waveform generators are used somewhere or other in most types of electronic equipment, and thus form one of the most widely used classes of circuit. They may be designed to produce outputs with sine, square, triangle, ramp, pulse, staircase, or a variety of other forms. The generators may produce modulated or unmodulated outputs, and the outputs may be of single or multiple form.

Waveform generator circuits may be built using transistors, op.amps, standard digital i.c.s, or dedicated waveform or "function" generator i.c.s.

The manual is divided into eleven chapters, and presents over 300 practical circuits, diagrams and tables. The subjects covered include: Basic principles; Sine wave generators; Square wave generators; Pulse generator circuits; "Timer i.c." generator circuits; Triangle and sawtooth generators; Multi-waveform generation; Waveform synthesizer i.c.s; Special waveform generators; Phaselocked loop circuits; Miscellaneous "555" circuits.

*267 pages* **Temporarily out of print**

# COMPUTING

### WINDOWS 95 EXPLAINED
**NEW**

**P. R. M. Oliver and N. Kantaris**

If you would like to get up and running, as soon as possible, with the new Windows 95 operating system, then this is the book for you.

The book was written with the non-expert, busy person in mind. It explains the hardware that you need in order to run Windows 95 successfully, and how to install and optimize your system's resources. It presents an overview of the Windows 95 environment.

Later chapters cover how to work with programs, folders and documents; how to control Windows 95 and use the many accessories that come with it; how to use DOS programs and, if necessary, DOS commands and how to communicate with the rest of the electronic world.

*170 pages* **Order code BP400** **£5.95**

### INTERFACING PCs AND COMPATIBLES
**R. A. Penfold**

Once you know how, PC interfacing is less involved than interfacing many eight-bit machines, which have tended to use some unusual interfacing methods.

This book gives you: A detailed description of the lines present on the PC expansion bus. A detailed discussion of the physical characteristics of PC expansion cards. The I/O map and details of the areas where your add-on can be fitted. A discussion of address decoding techniques. Practical address decoder circuits. Simple TTL 8-bit input and output ports. Details of using the 8255 parallel interface adaptor. Digital to analogue converter circuits. In fact everything you need to know in order to produce successful PC add-ons.

*80 pages* **Order code BP272** **£3.95**

### HOW TO CHOOSE A SMALL BUSINESS COMPUTER SYSTEM
**D. Weale**

This book is for anyone intending to buy an IBM compatible computer system, whether it is their first system or a replacement. There are sections on hardware, application and systems programs, and how to actually make your choice as well as sections on the law, ergonomics and a glossary of common terms. The text contains many useful tips and some warnings (which could save much effort and expense). After having read this book you should have a better idea of what is suitable for your needs, how to obtain it and how to ensure that the system is operated with the minimum of difficulty.

*144 pages* **Order code BP323** **£4.95**

### HOW TO EXPAND, MODERNISE AND REPAIR PCs AND COMPATIBLES (Revised Edition)
**R. A. Penfold**

Not only are PC and compatible computers very expandable, but before long most users actually wish to take advantage of that expandability and start upgrading their PC system. Some aspects of PC upgrading can be a bit confusing, but this book provides advice and guidance on the popular forms of internal PC expansion, and should help to make things reasonably straightforward and painless. Little knowledge of computing is assumed. The only assumption is that you can operate a standard PC of some kind (PC, PC XT, PC AT, or an 80386 based PC).

The subjects covered include: PC overview; Memory upgrades; Adding a hard disk drive; Adding a floppy disk drive; Display adaptors and monitors; Fitting a maths co-processor; Keyboards; Ports; Mice and digitisers; Maintenance (including preventative maintenance) and Repairs, and the increasingly popular subject of d.i.y. PCs.

*156 pages* **Order code BP271** **£5.95**

### THE PRE-BASIC BOOK
**F. A. Wilson, C.G.I.A., C.ENG., F.I.E.E., F.I.E.R.E., F.B.I.M.**

Another book on BASIC but with a difference. This one does not skip through the whole of the subject and thereby leave many would-be programmers floundering but instead concentrates on introducing the technique by looking in depth at the most frequently used and more easily understood computer instructions. For all new and potential micro users.

*192 pages* **Order code BP146** **£2.95**

### SERVICING PERSONAL COMPUTERS – 3rd EDITION
**Mike Tooley BA**

The revised and enlarged third edition contains a new chapter on servicing 68000 based microcomputers. It has been updated throughout and includes many new photos and diagrams. It is essential for anyone concerned with the maintenance of personal computer equipment or peripherals, whether professional service technician, student or enthusiast.

*240 pages* **Order code NE15** **£25**

### A CONCISE USER'S GUIDE TO MS-DOS 5
**N. Kantaris**

If you are a PC user and want to get the most out of your computer in terms of efficiency and productivity, then you must learn the intricacies of its MS-DOS operating system. With this book you will learn to do just that in the shortest and most effective way.

The book explains: The enhancements to be found in MS-DOS version 5, over previous versions of the operating system. How the DOS operating system is structured so that you can understand what happens when you first switch on your computer. How directories and subdirectories can be employed to structure your hard disk for maximum efficiency. How to use the DOS Shell program (a menu-driven graphical interface) to perform various house-keeping operations on your disk. How to manage disk files, and how to use the MS-DOS Editor to fully configure your system by writing your own CONFIG.SYS and AUTOEXEC.BAT files. How to optimise your system by either increasing its conventional memory or increasing its speed. How to write batch files to automate the operation of your system.

A summary of all DOS commands, illustrated with examples, is given in the penultimate chapter, which turns it into a useful reference guide.

*124 pages* **Order code BP318** **£4.95**

## DIRECT BOOK SERVICE
## ORDERING DETAILS

Please state the title and order code clearly, print your name and address and add the required postage to the total order.

Add **£1.50** to your total order for postage and packing (overseas readers **add £3** for countries in the EEC, or **add £6** for all countries outside the EEC, surface mail postage) and send a PO, cheque, international money order (£ sterling only) made payable to **Direct Book Service** or credit card details (including card expiry date), Visa or Mastercard (Access) – minimum credit card order is £5 – quoting your name and address, the order code and quantities required to **DIRECT BOOK SERVICE, 33 GRAVEL HILL, MERLEY, WIMBORNE, DORSET BH21 1RW** *(mail order only)*.

Although books are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

*Please check price and availability (see latest issue of Everyday Practical Electronics) before ordering from old lists.*

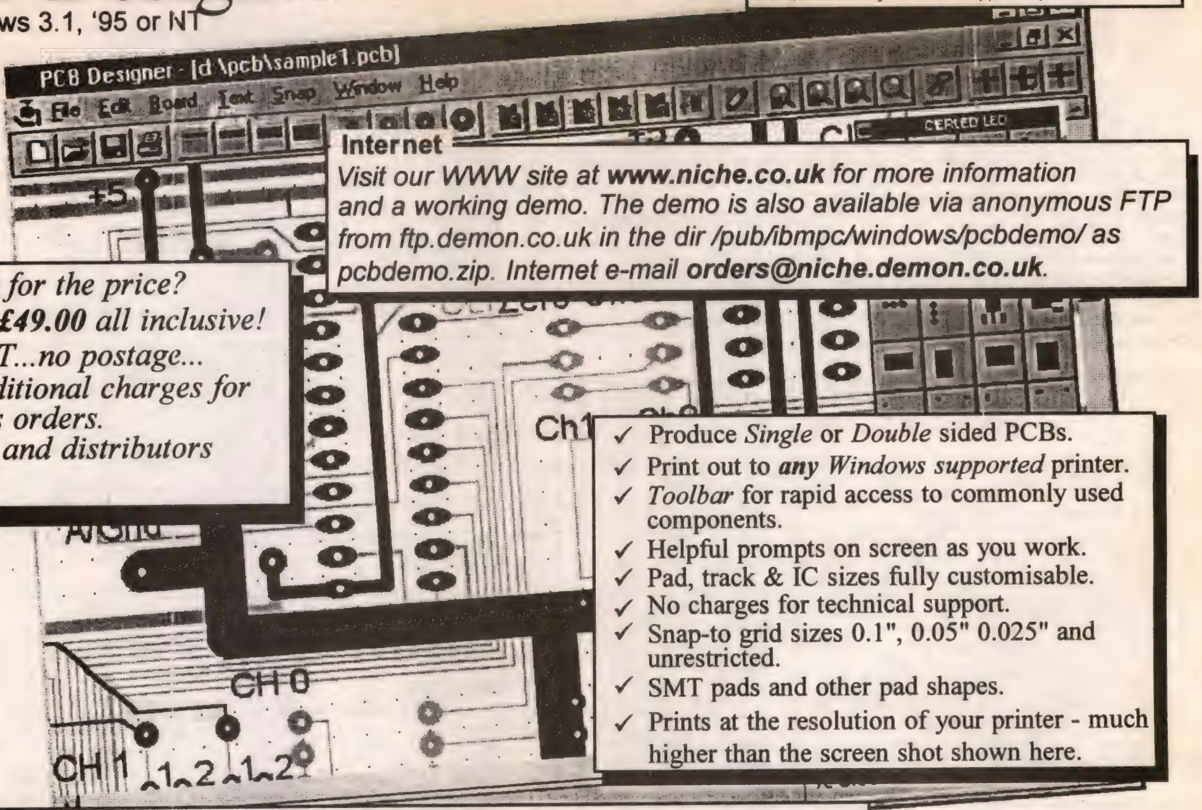
**For a further selection of books see next month's issue.**

**DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD.**

# PCB Designer

For Windows 3.1, '95 or NT

Runs on any PC running Windows 3.1, Windows 95 or Windows NT with a minimum 2MB RAM
Will work with any Windows supported printer and monitor


PCB Designer - [d:\pcb\sample1.pcb]
File Edit Board Text Snap Window Help
+5
CH 0
CH 1
Ch1

**Internet**

*Visit our WWW site at **www.niche.co.uk** for more information and a working demo. The demo is also available via anonymous FTP from ftp.demon.co.uk in the dir /pub/ibmpc/windows/pcbdemo/ as pcbdemo.zip. Internet e-mail **orders@niche.demon.co.uk**.*

*Looking for the price?*
*It's just **£49.00** all inclusive!*
*...no VAT...no postage...*
*...no additional charges for overseas orders.*
*Dealers and distributors wanted.*

- ✓ Produce *Single* or *Double* sided PCBs.
- ✓ Print out to ***any** Windows supported* printer.
- ✓ *Toolbar* for rapid access to commonly used components.
- ✓ Helpful prompts on screen as you work.
- ✓ Pad, track & IC sizes fully customisable.
- ✓ No charges for technical support.
- ✓ Snap-to grid sizes 0.1", 0.05" 0.025" and unrestricted.
- ✓ SMT pads and other pad shapes.
- ✓ Prints at the resolution of your printer - much higher than the screen shot shown here.

## Niche Software (UK)

22 Tavistock Drive, Belmont, Hereford, HR2 7XN. **Phone (01432) 355 414**

Access VISA

---

## Radio - Tech Limited

**Professional Suppliers of High Performance Radio Data Modules to Industry Throughout the World!**

A MEMBER OF LPRA LOW POWER RADIO ASSOCIATION

Official Holtek IC Distributors
HOLTEK
Encoders, Decoders, Regulators, Microcontrollers, Telephone, Speech

**SAW & Crystal Controlled Transmitters, Receivers & Transceivers, Synthesised & Spread Spectrum Transceivers, Test Jigs & Evaluation Boards, $2^8 > 3^{10}$ Data Encoders & Decoders, Antenna and More!**

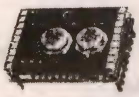
**APPLICATIONS:**
- ●Remote control systems
- ●Wire free PC-PC modems
- ●Remote Cable Free Monitoring
- ●Wire free security alarms
- ●Remote Meter Reading
- ●Industrial Process Control
- ●Lone Worker & Social Alarms

**All our 173.225MHz, 173.250MHz and 418MHz modules are DTI Type Approved and Licence Exempt within the UK !!!!**

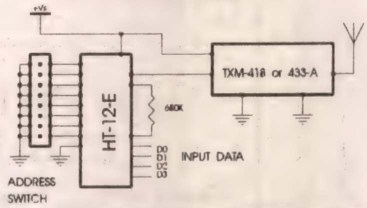
**Wire Free PC - PC Links, Hand Held Terminals and EPOS.**

**MPT1340**

**40K Bps**



Just add a RS232 Driver, Some Simple Logic & Terminal Software. Only £49.95 each. Development Kits £149.95 and Packet Controllers Board £ 79.95.Also Available on 433.92MHz

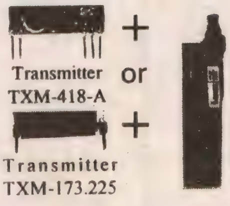


**SIMPLICITY**: Just add the HT-12-E Encoder and HT-12-D Decoder at £1.00 Each to Construct a Complete 4-Output Remote Control System !

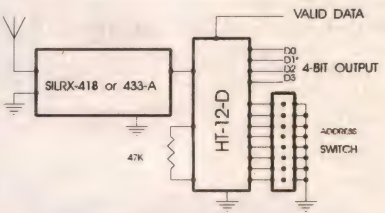
### NEW for '96:

**Plug and Play Evaluation Boards**

**418MHz**
**433MHz**
**173MHz**
**184MHz**
**0.25mW**
**1mW**
**10mW**



**Just add the TX or RX of Choice !**
Transmitter Eval Board From £ 29.95
Receiver Eval Board From £39.95



**NEW ! ANTENNA, REMOTE METER READING TX's, RX's and TX/RX's. HIGH POWER MPT1329 FREQUENCY AGILE SYNTHESISED TX/RX's & MPT1328 I.S. TRANSCEIVERS**

**Orders:** **Prices exclude carriage and VAT. Radio-Tech Limited, Overbridge House, 41 Weald Hall Lane, Thornwood Common, Epping, CM16 6NB, England. Telephone, Credit Card & Export Orders Welcome.**
**Tel: Sales 0181-368-8277 Fax 0181-361-3434, Int +44 1992 57 6107 Fax +44 1992 56 1994**

VISA

# PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remitances should be sent to **The PCB Service, *Everyday Practical Electronics,* Allen House, East Borough, Wimborne, Dorset BH21 1PF.** Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only).**

**NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.**

**Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.**

***Please check price and availability in the latest issue.***

**Boards can only be supplied on a payment with order basis.**

| PROJECT TITLE | | Order Code | Cost |
|---|---|---|---|
| Print Timer | JULY'94 | 874 | £5.82 |
| Watering Wizard | | 883 | £6.60 |
| Simple NiCad Charger | | 884 | £4.98 |
| Voxbox | | 885 | £6.90 |
| Stereo HiFi Controller – 1 Power Supply | | 886 | £5.66 |
| Stereo HiFi Controller – 2 | AUG'94 | | |
| Main Board | | 887 | £7.39 |
| Expansion/Display Boards (pair) | | 888 | £9.80 |
| Dancing Fountains – 1 Pre.amp | | 889 | £5.28 |
| Pump Controller | | 890 | £5.41 |
| Filter | | 891 | £5.23 |
| 6802 Microprocessor Development Board | | 894 | £9.15 |
| Dancing Fountains – 2 | SEPT'94 | | |
| PC-Compatible Interface (double-sided) | | 892 | £10.90 |
| Automatic Greenhouse Watering System | | 895 | £5.33 |
| Seismograph – 1 Sensor/Filter | | 896 | £6.23 |
| Clock/Mixer | | 897 | £5.87 |
| 3-Channel Lamp Controller | | 899 | £8.17 |
| Seismograph – 2 | OCT'94 | | |
| PC-Compatible Interface (double-sided) | | 898 | £10.72 |
| Visual/Audio Guitar Tuner | | 900 | £7.55 |
| Digilogue Clock | | 901 | £12.50 |
| Hobby Power Supply | | 902 | £5.00 |
| Audio Auxiplexer – Control Board | | 903 | £7.72 |
| Receiver | | 904 | £6.24 |
| Power Controller | NOV'94 | 905 | £4.99 |
| 1000V/500V Insulation Tester | | 906 | £5.78 |
| Active Guitar Tone Control | | 907 | £4.50 |
| TV Off-er (pair) | | 908/909 | £7.25 |
| Video Modules – 1 Simple Fader | | 910 | £5.12 |
| Improved Fader | | 911 | £6.37 |
| Video Enhancer | | 912 | £5.15 |
| Rodent Repeller | DEC'94 | 913 | £6.26 |
| EPE Fruit Machine | | 914 | £8.14 |
| Video Modules – 2 Horizontal Wiper | | 916 | £6.23 |
| Vertical Wiper | | 917 | £6.35 |
| 4-Channel Audio Mixer | | 918 | £6.20 |
| Spacewriter Wand | | 921 | £4.00 |
| Universal Digital Code Lock | | 922 | £6.25 |
| Video Modules – 3 | JAN'95 | | |
| Dynamic Noise Limiter | | 919 | £5.92 |
| System Mains Power Supply | | 920 | £4.98 |
| Magnetic Field Detector | | 923 | £5.77 |
| Model Railway Track Cleaner | | 924 | £5.11 |
| Moving Display Metronome | | 925 | £6.24 |
| The Ultimate Screen Saver | FEB'95 | 927 | £5.66 |
| Foot-Operated Drill Controller | | 928 | £5.73 |
| Model Railway Signals | | 929 | £5.96 |
| 12V 35W PA Amplifier | | 930 | £12.25 |
| Multi-Purpose Thermostat | MAR'95 | 931 | £6.30 |
| Multi-Project PCB | | 932 | £3.00 |
| Sound-Activated Switch | | | |
| Audio Amplifier | | | |
| Light Beam Communicator (2 boards required) | | | |
| Multi-Project PCB | APR'95 | 932 | £3.00 |
| Light-Activated Switch | | | |
| Switch On/Off Timer | | | |
| Continuity Tester | | | |
| Auto Battery Charger | | 934 | £5.36 |
| National Lottery Predictor | | 935 | £5.34 |
| R.F. Signal Generator - R.F./Mod. | MAY'95 | 936 | £6.48 |
| Coil & Power Supply (pair) | | 937a/b | £6.10 |
| MIDI Pedal | | 938 | £7.78 |
| Club Vote Totaliser | | 939 | £6.05 |
| PIC-DATS Development System (double-sided p.t.h.) | | 940 | £9.90 |
| EPE HiFi Valve Amplifier – Phase splitter | JUNE'95 | 941 | £6.71 |
| PIC-DATS 4 -channel Light Chaser | | 942 | £7.90 |

| PROJECT TITLE | | Order Code | Cost |
|---|---|---|---|
| HV Capacitor Reformer | JULY'95 | 943 | £5.60 |
| Ramp Generator | | | |
| Logic Board (double-sided p.t.h.) & Analogue board (pair) | | 944/5 | £32.00 |
| Automatic Curtain Winder | | 946 | £6.75 |
| Windicator | | 947 | £4.10 |
| Microcontrolled 3-Digit Timer | AUG'95 | 933 | £6.61 |
| IR Remote Control – Transmitter | | 948 | £5.76 |
| – Receiver | | 949 | £6.14 |
| Personal Practice Amplifier | | 950 | £6.09 |
| Low-Range Ohmmeter Adaptor | SEPT'95 | 926 | £5.55 |
| Simple Theremin | | 952 | £6.68 |
| Vandata | | | |
| Boot Control Unit | | 953 | £10.52 |
| Display Unit | | 954 | £6.61 |
| Sound Switch | OCT'95 | 915 | £6.55 |
| Multiple Project PCB | | 932 | £3.00 |
| Audio Sinewave Generator | | | |
| Treble Booster | | | |
| Infra-Red Controller/Alarm (2 boards required) | | | |
| Capacitor Check | | 955 | £5.76 |
| Ginormous VU Meter | | 956 | £9.31 |
| Multiple Project PCB | NOV'95 | 932 | £3.00 |
| Video Enhancer | | | |
| Current Tracer | | | |
| Distortion Effects Unit | | | |
| Digital Delay Line | | 958 | £8.04 |
| 50Hz Field Meter | | 959 | £8.32 |
| Temperature Warning Alarm (Teach-In '96) | | 960 | £6.15 |
| Stereo "Cordless" Headphones | DEC'95 | | |
| Transmiter | | 961 | £8.04 |
| Receiver | | 962 | £7.66 |
| EPE Met Office – Sensor/Rainfall/Vane | | 963/965 | £11.33 |
| Spiral transparency free with above p.c.b. | | | |
| Light-Operated Switch | | 966 | £6.37 |
| Modular Alarm System (Teach-In '96) | | 967a/b | £7.12 |
| Audio Meter and Amplifier | | 968 | £5.99 |
| EPE Met Office – | JAN'96 | | |
| Computer Interface (double-sided) | | 964 | £7.69 |
| Audio Signal Generator | | 969 | £6.58 |
| Mains Signalling Unit, Transmitter and Receiver | | 970/971 (pr) | £9.09 |
| Automatic Camera Panning (Teach-In '96) | | 972 | £6.63 |
| Printer Sharer | | 973 | £9.93 |
| Analogue Frequency Meter | FEB'96 | 957 | £6.70 |
| Vari-Speed Dice (Teach-In '96) | | 974 | £5.69 |
| Mains Signalling Unit – 2 | | | |
| 12V Capacitive PSU | | 975 | £6.07 |
| Multi-Purpose Mini Amplifier | MAR'96 | 976 | £6.12 |
| PIC-Electric Meter – Sensor/PSU– Control/Display | | 977/978 (pr) | £9.90 |
| High Current Stabilised Power Supply | | 979 | £6.62 |
| Mind Machine Mk III | | 980 | £7.39 |
| Infra-Zapper Transmitter/Receiver | | 981/982(pr) | £8.01 |

## EPE PRINTED CIRCUIT BOARD SERVICE

**Order Code** **Project** **Quantity** **Price**

..............................................................................................

Name..............................................................................................

Address..............................................................................................

..............................................................................................

..............................................................................................

I enclose payment of £...............................(cheque/PO in **£ sterling only**) to:

**Everyday Practical Electronics**

**Access (MasterCard) or Visa No.**
**Minimum order for credit cards £5**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |

Signature.......................................................Card Exp. Date............................

Please supply name and address of cardholder if different from the address shown

# REPORTING AMATEUR RADIO

## Tony Smith G4FAI

### IARP ADOPTED BY OAS

An International Amateur Radio Permit (IARP) has been adopted by the Organization of American States. The OAS is "convinced of the benefits of Amateur Radio" and has agreed "to facilitate and promote, by all means within its power, the continuing development of telecommunications in the countries of the Americas."

The IARP will be used by radio amateurs who are citizens of countries in North, Central and South America and the Caribbean, and who travel to other countries in that area.

The permit will operate rather like an international driver's licence. As conceived there will be two classes of permit: Class 1 will allow use of all amateur frequency bands to amateurs who have passed a Morse test in their own country, while Class 2 allows operation in the amateur bands above 30MHz.

Region 2 of the International Amateur Radio Union has been trying for more than 13 years to achieve an amateur radio licence recognized worldwide for travelling amateurs. Now it has been adopted by the Americas, the International Amateur Radio Permit has the potential to be eventually adopted everywhere.

The permit is currently in the process of being ratified by the various OAS member states. (Information from *The Canadian Amateur*).

### NEWS FROM ISWL

The International Short Wave League has a new Honorary Secretary and a new headquarters. From January 1996, the Secretary is Mrs M.H. Carrington G0WDM, and all correspondence with the League should be addressed to *ISWL HQ, 3 Bromyard Drive, Chellaston, Derby DE73 1PF*.

The ISWL was founded in 1946 with the objectives of: a) bringing together Shortwave radio enthusiasts of the world regardless of Race, Creed or Politics; b) Fostering and promoting international goodwill through the medium of Shortwave radio; and c) Providing facilities to enable enthusiasts to carry out their hobby resulting in the greatest advantage to them and their fellow enthusiasts.

Such was the enthusiasm for the League's activities in the 1950s, that for a while several international broadcast stations, including HCJB Ecuador, Radio Turkey and Radio Spain, carried ISWL programmes.

In 1986, the ISWL ceased operation for a short period, but after reorganization, it recommenced activities in early 1987. Nowadays it is as enthusiastic as ever and membership remains open to anyone with an interest in amateur radio or shortwave listening.

### 50TH ANNIVERSARY

As 1996 sees the 50th anniversary of the formation of the League, members will be operating a special event callsign, GB50SWL, throughout the year.

Anyone hearing or working this callsign can receive the GB50SWL QSL card, by sending their own QSL or reception report via the bureau, or direct to the ISWL Club Callsign Manager, David Beale G0DBX, "Kenwood", London Road, Louth, Lincs LN11 8QH.

ISWL has several on-air nets each week, and there is an on-going programme of awards and contests, details of which are carried in the League's monthly journal *Monitor*. The ISWL encourages the exchange of QSL cards following amateur radio or shortwave listening activities, and has a QSL bureau for members for this purpose.

Additionally, it sells stationary and supplies for members, including QSL cards, ties, car stickers, reporting pads, etc. It also has a number of useful publications, including the twice-yearly *Guide to English Language Short Wave Broadcasts to Europe*.

The current subscription for ISWL membership is £18.00 per year, plus a further £6.00 for the services of the QSL bureau if required. Any quantity of cards can be sent through the bureau without restriction, and addressees do not have to be ISWL members – an important point for keen QSLers.

For more information about the League, write to the new address above, and be sure to mention that you read about the League and its activities in *EPE*.

### REPEATER PROBLEMS

As reported in this column recently the Radiocommunications Agency, in its Annual Report for 1994/95, mentioned its concern at the continuing abuse of the amateur radio and CB services.

One of the main problems in amateur radio in the UK is abuse of repeaters. These are devices that receive radio signals on one frequency and simultaneously retransmit them on another. This way, they increase the range of low power mobile stations from a few miles to a much greater distance, depending on the terrain and the frequency used.

They are unmanned VHF or UHF stations sited on high ground, a tall building, or a tall mast to obtain a coverage area vastly greater than that of the stations working through them. The first amateur repeaters were brought into use in the early 1970s and were used for FM speech communication only. Nowadays there are repeaters for several other modes apart from FM.

From the time they began, a number of VHF/FM repeaters have suffered from the disruptive behaviour of a small number of operators. In the worst cases, they make new users unwelcome, interrupt on-going contacts with foul language, abuse, or illegal transmissions of music, and generally block access to a repeater for others who wish to use it.

### MORE CONTROL REQUIRED

Various attempts have been made to deal with this problem over the years. A few identified offenders have been banned by the Radiocommunications Agency from using particular repeaters, and one or two repeaters have been closed down for a few months at a time in the hope that things would improve.

According to some users, however, the situation is no better and they feel that much stronger measures should be taken to deal with the problem. One correspondent to this column suggests that repeaters suffering serious abuse should only be allowed on the air when there is a "control operator" constantly monitoring transmissions, with the ability to switch the repeater off and back on again as required.

If the groups who put the repeaters on the air are not prepared to police them like this, he suggests that affected repeaters be closed down for a period of six months. If, on return to service they still suffer more abuse than proper use, they should be closed down permanently.

### IS THERE ANOTHER WAY?

Many amateurs do not use repeaters because of their reputation, or because of their own experiences. Equally there are many who do use them and enjoy them despite the problems described.

The latter are unlikely to agree with the idea of permanent closedown of an unmanageable repeater, but if a problem remains unsolved for over twenty years, then surely previous measures must be judged as having failed?

Before I am inundated with protests, my correspondent does say that only a few well-known repeaters suffer this problem, and that most *ARE* used properly. He feels that the Radiocommunications Agency, although having limited resources, should take a more active interest in the matter in the interests of the amateur community.

It would be interesting to hear from regular repeater users what they think about all this. Why have previous measures failed? Can anything else can be done short of permanently closing down the most abused repeaters?

### LF ALLOCATION SOON

As a result of ongoing negotiations between the RSGB and the Radiocommunications Agency, the RA has agreed an amateur frequency allocation around 73kHz. Discussions on the actual terms of licensing are continuing.

## *The Security Centre (EST. 1980)*

**275 Linthorpe Road, Middlesbrough, Cleveland TS1 4AS**
**Telephone (01642) 241151**
***OPEN MONDAY-FRIDAY 9A.M. UNTIL 5P.M. SATURDAY 9A.M.-1P.M.***

### D.I.Y ALARM KITS AT GREATLY REDUCED PRICES!

### *SALE NOW ON OF A FULL D.I.Y. KIT. BUY THE FULL KIT AND SAVE OVER £17!*

**KIT COMPRISES OF:**
**ONE ZX6 6 ZONE PUSH BUTTON PANEL.**
**ONE STANBY RECHARGING BATTERY.**
**ONE P.I.R. MOVEMENT DETECTOR.**
**ONE FRONT DOOR SWITCH.**
**ONE POLYCARBONATE BELL BOX.**
*(NOT to be confused with the cheaper POLPROPYLENE box)*
**ONE LOUD EXTERNAL SIREN.**
**50 METRES FOUR CORE CABLE.**
**100 CABLE CLIPS.**

***IF PURCHASED SEPARATELY THIS KIT WOULD COST OVER £86!!***

***SALE PRICE FOR THE FULL KIT:***

***£69.00!***

*OVERNIGHT CARRIAGE £8.00 (VAT INCLUDED)*

*(SAVING OVER £17!)*

***Offer on while stocks last. Discount vouchers excluded.***

---

| | |
|---|---|
| 3lb mixed component pack | £4.95 |
| Jumbo component pack | £10 |
| 250 off mixed capacitors | £4.95 |
| 250 off i.c. sockets | £3.95 |
| 1000 off mixed ceramic caps | £7.50* |
| 20 off mixed crystals/filters | £4.95 |
| 25 off mixed relays | £3.50 |
| 100 off phono plugs | £2.95* |
| 10 off mixed displays | £3.75* |
| 50 off d.i.l. switches | £3.75* |
| 30 off mixed heatsinks | £3.75* |
| 30 off mixed switches | £3.75* |
| Brand new 360k 5¼" floppy drive | £4.50 |
| 5¼" to 3½" floppy drive converter leads | £1.50* |
| 50Ω BNC to BNC lead | £1.75 |
| 2 phono plug to 2 phono plug lead | £1.50* |
| 21-Pin SCART plug to SCART plug lead (all connected) | £3.50* |
| As above but plug to socket | £3.50* |
| SCART plug to 4 phone plug lead | £2.95 |
| 10 off crocodile clip leads | £3.50* |
| Universal Test Lead Kit | £3.75* |

**VALVES**

QQV0310, **£10***; QQV0320A, **£10***; QQV0640A, **£20***; ECC82, **£3***; ECH81, **£2***; PCL805, **£3***; ORP 11, **£3**; ORP 40, **£3**; CV 4004, 4005, 4006, 4007, 4014, 4020, 4024, 4043, 4055, 4064, 5042, 5080, ALL **£5** each*.

**QUANTITY DISCOUNTS AVAILABLE PLEASE RING.**
We also buy all forms of electronic components, p.s.u's, disk drives etc. Lists to below address.

*ALL PRICES INCLUDE V.A.T. PLEASE ADD £2.00 p&p EXCEPT ITEMS MARKED★ WHICH ARE 50P. SAE FOR BULK BUYING LIST PAYMENT WITH ORDER TO:*

**Dept EE, COMPELEC,**
**14 Constable Road,**
**St. Ives, Huntingdon,**
**Cambs PE17 6EQ**
**Tel/Fax: 01480 300819**

---

## JCG ELECTRONIC PROJECTS

**PO BOX HP79 WOODHOUSE STREET HEADINGLEY LEEDS LS6 3XN**

### KITS

### RADIO KITS/TRANSMITTERS/ REMOTE CONTROLS

**MICRO FM (a).** 1km range transmitter, 80-100MHz preset. Received on any FM Radio. 2 x 3cm. **£6.95**
**MICRO FM (b).** Variable mic. sensitivity. Tuneable 80-110MHz. 1km range, 2 x 3·5cm **£7.95**
**ULTRA MINI FM.** 200mtrs range. 80-100MHz, runs off watch battery (inc.), only 1 x 2cm **£8.95**
**FM TRACKER.** Transmits a constant tone for direction finding, tracking etc. 80-110MHz **£8.50**
**FM RECEIVER (a).** Small high quality FM receiver. Covers standard FM broadcast bands. Will drive headphones (not inc.) **£10.90**
**FM RECEIVER (b).** As (a) but with 3 watt audio power amplifier and tuning LED **£13.50**
**CRYSTAL RADIO.** Great introduction to radio electronics. Includes tuner, ferrite aerial and earphone **£8.50**
**AM RADIO.** Single chip radio for use with headphones, (not inc.) or an external amplifier **£9.90**
**I.R. REMOTE CONTROL.** Single channel for lights, garage doors etc. Transmitter – **£6.95**
Receiver (with mains relay) – **£11.60**
**27MHz RADIO CONTROL.**
Single channel, XTAL controlled Transmitter – **£9.50**
Receiver (with mains relay) – **£15.45**

### PREAMPS/AUDIO

**AU10 GENERAL PURPOSE PREAMP** for audio applications where low noise isn't a priority – guitar amps etc. 9V-15V, variable gain and high output **£4.20**
**AU11 LOW NOISE PREAMP** for more critical input stages. Ideal for mixers etc. 9V-15V, variable gain **£4.50**
**AU12 ULTRA LOW NOISE PREAMP.** Professional standard. Uses an NE5534 i.c. 9V-15V, variable gain **£5.99**
**AU13 SMALL SIGNAL.** Single FET preamp for boosting low output piezo pickups or acoustic transducers **£3.90**
**AU14 SMALL SIG + EQ.** An AU13 with a simple three-band passive EQ circuit. Designed for piezo pu's **£6.90**
**AU15 SINGLE TRANSISTOR.** Low noise preamp for electric guitars etc. Preset gain. BC184L **£3.90**
**AU16 ACTIVE TONE CONTROL.** 12dB cut and boost, bass and treble with preamp. Includes pots. **£9.95**
**AU17 7-BAND EQ** board for graphic/tone control applications. Pots included **£14.95**
**AU18 NOISE REDUCTION SYSTEM.** High quality dynamic noise gate with variable effect and level **£15.95**
**AU19 ANALOGUE DELAY.** "Bucket brigade" delay line. Variable clock frequency for producing double track and echo effects etc. Delay times from 2·5 to 51ms. **£18.50**
**AU20 CONTROL OSC.** Low frequency oscillator to modulate the analogue delay line for Flanging, Chorus and other effects **£8.50**
**AU21/21 DIGITAL DELAYS.** 200ms and 800ms digital delay lines with 10-bit A/D D/A conversion. Variable sample rate from 25kHz-50kHz variable delay time, 200ms – **£20.40,** 800ms – **£24.95**

### POWER AMPS

**P2 15 WATT.** General purpose upgrade. Uses TDA2030. 24V single rail with heatsink **£9.95**
**P3 40 WATT.** High quality power amp for compact disc and other demanding applications. Switch on mute, thermal/short protecction. Distortion less than 0·003% 27V ± with heatsink. **£15.50**
**P4 150 WATT.** Rugged and powerful MOSFET design, excellent responses and reliability. 50V ± with heatsink. Ideal for guitar amps. PA or sound system. **£24.95**

### MICRO TRANSMITTERS GUIDE

★ **Only £3.95**

★ Easy to follow guide to building short range F.M. transmitters and surveillance devices. Packed with useful information and circuits.

(Some of the circuits included cannot be used legally in the UK)

*SEND S.A.E. FOR A LIST OF OUR FULL RANGE OF RADIO AND AUDIO KITS. ALL KITS COME COMPLETE WITH PRE-DRILLED P.C.B.'s, HIGH SPEC COMPONENTS AND FULL INSTRUCTIONS - MAIL ORDER ONLY - MAKE CHEQUES/PO'S PAYABLE TO J.C.G. PLEASE ADD 50p POSTAGE AND PACKING.*

---

## SHERWOOD ELECTRONICS

Special Packs **£1** each – choose 1 x £1 pack FREE with every 10 purchased

| | | |
|---|---|---|
| SP1 | 15 x | 5mm Red Leds |
| SP2 | 15 x | 5mm Green Leds |
| SP3 | 12 x | 5mm Yellow Leds |
| SP4 | 10 x | 5mm Amber Leds |
| SP6 | 15 x | 3mm Red Leds |
| SP7 | 12 x | 3mm Green Leds |
| SP8 | 10 x | 3mm Yellow Leds |
| SP10 | 100 x | 1N4148 diodes |
| SP11 | 30 x | 1N4001 diodes |
| SP12 | 30 x | 1N4002 diodes |
| SP18 | 20 x | BC182 transistors |
| SP19 | 20 x | BC183 transistors |
| SP20 | 20 x | BC184 transistors |
| SP21 | 20 x | BC212 transistors |
| SP22 | 20 x | BC214 transistors |
| SP23 | 20 x | BC549 transistors |
| SP24 | 5 x | Cmos 4001 |
| SP25 | 4 x | 555 timers |
| SP26 | 4 x | 741 Op.amps |
| SP27 | 5 x | Cmos 4002 |
| SP28 | 5 x | Cmos 4011 |
| SP29 | 4 x | Cmos 4013 |
| SP31 | 4 x | Cmos 4071 |
| SP32 | 4 x | Cmos 4077 |
| SP36 | 25 x | 10/25V radial elect caps |
| SP37 | 15 x | 100/35V radial elect caps |
| SP41 | 20 x | Mixed transistors |
| SP42 | 200 x | Mixed 0.25W C.F. resistors |
| SP43 | 2 x | LM1458 |
| SP47 | 5 x | Min. pushbutton switches |
| SP102 | 20 x | 8-pin DIL sockets |
| SP103 | 15 x | 14-pin DIL sockets |
| SP104 | 15 x | 16-pin DIL sockets |
| SP105 | 5 x | 74LS00 |
| SP106 | 5 x | 74LS02 |
| SP109 | 15 x | BC557 transistors |
| SP112 | 5 x | Cmos 4093 |
| SP115 | 3 x | 10mm Red Leds |
| SP116 | 3 x | 10mm Green Leds |
| SP118 | 2 x | Cmos 4047 |
| SP119 | 4 x | Cmos 4072 |
| SP125 | 10 x | 1000/16V radial elect caps |
| SP130 | 100 x | Mixed 0.5W C.F. resistors |
| SP133 | 20 x | 1N4004 diodes |
| SP134 | 15 x | 1N4007 diodes |
| SP135 | 6 x | Min. slide switches |
| SP136 | 3 x | BFY50 transistors |
| SP137 | 4 x | W005 1.5A bridge rectifiers |
| SP142 | 2 x | Cmos 4017 |
| SP144 | 3 x | TIP31A transistors |
| SP145 | 6 x | ZTX300 transistors |
| SP146 | 10 x | 2N3704 transistors |
| SP151 | 4 x | 8mm Red Leds |
| SP152 | 4 x | 8mm Green Leds |
| SP153 | 4 x | 8mm Yellow Leds |
| SP154 | 15 x | BC548 transistors |
| SP156 | 3 x | Stripboard, 14 strips/ 27 holes |
| SP160 | 10 x | 2N3904 transistors |
| SP161 | 10 x | 2N3906 transistors |
| SP165 | 2 x | LF351 Op.amps |
| SP167 | 6 x | BC107 transistors |
| SP170 | 2 x | LM339 quad volt comp. |
| SP174 | 20 x | 22/25V radial elect caps |
| SP175 | 20 x | 1/63V radial elect caps |
| SP182 | 20 x | 4.7/50V radial elect caps |
| SP187 | 15 x | BC239 transistors |
| SP191 | 3 x | Cmos 4023 |
| SP193 | 20 x | BC213 transistors |
| SP194 | 10 x | OA90 diodes |
| SP195 | 3 x | 10mm Yellow Leds |

RESISTOR PACKS – 0.25W C.Film

| | | |
|---|---|---|
| RP3 | 5 each value – total 365 | £2.60 |
| RP7 | 10 each value – total 730 | £3.95 |
| RP10 | 1000 popular values | £5.30 |

Catalogue £1 inc. P&P or **FREE** with first order.
P&P £1.25 per order. **NO VAT.**

Orders to:
**Sherwood Electronics,**
**7 Williamson St., Mansfield,**
**Notts. NG19 6TD.**

---

## PEAK Transistor Analyser

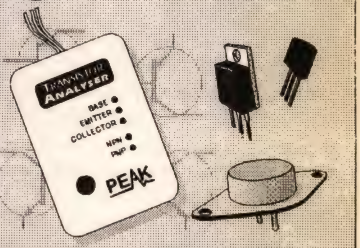
**Model: DTA30**

### *Could Not Be Simpler!*

**The DTA30 is an advanced microcontrolled instrument that will quickly and easily analyse any type of bipolar transistor.**

**The unit is connected to the component under test any way round.**

**You DO NOT need to know the pinout first!**



**Press the button and the Analyser instantly identifies the Base, Emitter and Collector of the transistor by means of multicolour LEDs. The device type is also displayed, NPN or PNP.**

**If the transistor under test is not working in any way, such as an open or a short junction, no gain or high leakage, the Analyser will display a "FAIL" diagnosis with three flashing red LEDs. The unit also features automatic power-up and power-down and provides years of service from one tiny battery.**

**Small enough for the shirt pocket, yet powerful enough to tell you what you really want to know.**

***Does this transistor work?***
***What's the pinout for this transistor?***
***I only need an NPN transistor, is this one?***

**For your free comprehensive data sheet write to the address below. Alternatively, order a DTA30 now and if you are not entirely satisfied with your DTA30 we will refund your money with no questions asked.**

**The DTA30 costs only £29.95 inc. VAT per unit. Please add £3.50 (£7 overseas) towards shipping costs for each order.**

PEAK ELECTRONIC DESIGN LTD
70 Nunsfield Road, Buxton, Derbyshire, SK17 7BW. Tel (01298) 79920.

# EVERYDAY PRACTICAL ELECTRONICS CLASSIFIED

**Everyday Practical Electronics reaches nearly twice as many UK readers as any other independent monthly hobby electronics magazine, our audited sales figures prove it. We have been the leading independent monthly magazine in this market for the last eleven years**

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2·5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, Holland Wood House, Church Lane, Great Holland, Essex CO13 0JS. Phone/Fax (01255) 850596.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

---

**RCS VARIABLE VOLTAGE D.C. BENCH POWER SUPPLY**

Up to 38 volts d.c. at 6 amps continous, 10 amps peak, fully variable from 1 to 38 volts. Twin Voltage and Current meters for easy read-out. 240 volt a.c. input. Fully smoothed, size 14½ x 11 x 4½ inches.

**£96** inc. VAT

**carriage £6**

**RADIO COMPONENT SPECIALISTS**

337 WHITEHORSE ROAD, CROYDON
SURREY, CR0 2HS. Tel: 0181-684 1665

**Lots of transformers, high volt caps, valves, speakers, in stock. Phone or send your wants list for quote.**

---

**CIRCUIT SOLUTIONS**

Send in your Electronics Design problem, and £15. We will advise and/or send a solution in sketch format by return of post. Some free backup given.

**ASSOCIATED CONSULTANT ENGINEERS**
The Blue Bell, Wrangle Bank,
Wrangle. Nr. Boston. PE22 9DL

---

**Z88**

**CAMBRIDGE Z88 A4 NOTEBOOK COMPUTER AVAILABLE AGAIN £99.**

ONLY 1" THICK, 4xAA BATTS. 20 HOURS WORK. LCD SCREEN, 72 Crs, 6 LINES, 82K RAM, EXTRA RAMS & EPROMS, 9 pin D SERIAL PORT, ROM HAS BBC BASIC, W/PROCESSOR, SPREADSHEET, DATA BASE, IMP/EXPORT TO PC etc, V52 TERMINAL.

***W.N. RICHARDSON & CO.***
*PHONE/FAX 01494 871319*
*6 RAVENSMEAD, CHALFONT ST PETER,*
*BUCKS, SL9 0NB.*
*POST £5. ACCESS, VISA, ETC.*

---

**THE PARALLEL INTERFACE POWER CARD by HANDDI Ltd for complete COMPUTER CONTROL.**

This could be your most useful and cheapest computer/PC "add-on" at only £19.95 . . . Post FREE!
Drives robotics, motor speeds, steeper motors, lamps, relays etc. using its 8 x 20V/2A outputs.
Many sold already for successful Model Railway Layout control . . . FULL INSTRUCTIONS supplied!

**Send cheque for £19.95 OR S.A.E. for details to:–**
**HANDDI Ltd. P.O. 503, Milton Keynes, MK5 6JD.**

---

**BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING**

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT AN EQUAL OPPORTUNITIES PROGRAMME

O.N.C., O.N.D. and H.N.C.

*Next course commences*
***Monday 22nd April 1996***
*FULL PROSPECTUS FROM*

LONDON ELECTRONICS COLLEGE
(Dept EPE) 20 PENYWERN ROAD
EARLS COURT, LONDON SW5 9SU
TEL: 0171-373 8721

---

**THE BRITISH AMATEUR ELECTRONICS CLUB**

exists to help electronics enthusiasts by personal contact and through a quarterly Newsletter.

For membership details, write to the Secretary:

**Mr. J. F. Davies,**
**70 Ash Road, Cuddington,**
**Northwich, Cheshire CW8 2PB.**

***Space donated by Everyday Practical Electronics***

---

**EVERYDAY PRACTICAL ELECTRONICS**

**SUBSCRIPTION ORDER FORM**

**Annual subscription rates (1996):**
**UK £24.00.**

**Overseas £30.00 surface mail, £47.50 airmail.**

**To:**
**Everyday Practical Electronics,**
**Allen House, East Borough,**
**Wimborne,**
**Dorset BH21 1PF**
**Tel: 01202 881749**
**Fax: 01202 841692**

**Name** ..................................................

**Address** ..................................................

..................................................

..................................................

..................................................

**I enclose payment of £**..........................

(**cheque/PO in £ sterling only**, payable to Everyday Practical Electronics). Alternatively send Access or Visa number and card expiry date.

Signature ..................................................

Please supply name and address of cardholder if different from the subscription address shown above. **Subscriptions can only start with the next available issue.** For back numbers see the Back Issues page.

M3/96

---

## Miscellaneous

**PROTOTYPE PRINTED CIRCUIT BOARDS** one offs and quantities, for details send s.a.e. to B. M. Ansbro, 38 Poynings Drive, Hove, Sussex BN3 8GR, or phone Brighton 883871.

**G.C.S.E. ELECTRONICS KITS,** at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT Electronics, 70 Oxford Road, Clacton, CO15 3TE.

**PLDs AND EPROMS** copied or programmed. We supply logic devices/convert discrete logic to PLDs. Also PCBs designed. Send for details to PO Box 1561 Bath (01225 444467).

**VALVE ENTHUSIASTS:** Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel: 01788 574774.

**PRINTED CIRCUIT BOARDS – QUICK SERVICE.** Prototype and Production. Artwork raised from magazines or draft designs at low cost. PCB's also designed from schematics. Production assembly also undertaken. For details send to P. Agar, 36 Woodcot Avenue, Belfast, BT5 5JA or phone 01232 473533 (7 days).

**AMAZE YOUR FRIENDS** with your own "PLASMA DISPLAY LAMP". Fascinating science project! Complete kit only £24.95 (+£1.50 p&p) or plans only £5.95 (+50p p&p). Cheques or postal orders to: P.P.S., 33B Rowlands Road, Worthing, W. Sussex, BN11 3JJ.

**HIGH VOLTAGE DC-DC CONVERTERS,** PCB Mounting, 12/24 volt input. Fully encapsulated, ideal for GEIGER, PHOTOMULTIPLIER and ION MOTOR experiments. 2kV Unit £19.00 each or 10kV Unit £49.00 each. Quantity discounts available direct from manufacturer. S.A.E. for further information to:– P.P.S., 33B Rowlands Road, Worthing, W. Sussex, BN11 3JJ. 01903 214100.

**STEREO AMPLIFIERS,** 30W + 30W £9.95p. 4 push selector +T.B.V. controls. Catalogue £1.00, +projects +samples. K.I.A., 1 Regent Road, Ilkley.

**HUGE SUPPLY OF SURPLUS RADIO COMMUNICATIONS EQUIPMENT** Base stations from £30; mobile AM and FM transceivers from £10; heavy duty power supplies; VHF and UHF aerials, all very cheap. Send S.A.E. for list, SMC, P.O. Box 17, Brierley Hill, West Midlands, DY5 3WJ.

**EVERYDAY PRACTICAL ELECTRONICS:** January '90 – February '96. BBC Master computer, monitor, double disk drive, software, manuals. Epson LX-400. All v.g.c. Will split. Plus postage/buyer collects (Humberside/Manchester). (0161) 4456400.

## MAKE YOUR INTERESTS PAY!

Over the past 100 years more than 10 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 100 years experience in home-study courses, and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert 'personal' tutors. Find out how we can help YOU. Post or phone today for **FREE INFORMATION** on the course of your choice. (Tick one box only!)

**GCSE/'A' LEVEL** over 20 examination subjects to choose from. Ask for details.

| | | | |
|---|---|---|---|
| Electronics | ☐ | TV, Video & Hi-Fi Servicing | ☐ |
| C & G Basic Electronic Engineering | ☐ | Refrigeration & Air Conditioning | ☐ |
| Electrical Engineering | ☐ | PC Repair | ☐ |
| Electrical Contracting/Installation | ☐ | Computer Programming | ☐ |

Mr/Mrs/Miss/Ms ____________________

Address ____________________

____________________ P.Code ____________

**ICS** International Correspondence Schools, Dept. **ZEEEAC**, 312/314 High Street, Sutton, Surrey SM1 1PR. Tel: 0141-221 7373 (24 hours). Fax: 0141-221 8151.

## SERVICE MANUALS & Technical Books

Available for most equipment, any make, age or model.
Return the coupon for your FREE catalogue

**MAURITRON TECHNICAL SERVICES (EPE)**
8 Cherry Tree Road, Chinnor, Oxon, OX9 4QY.
*Tel:- 01844-351694. Fax:- 01844 352554.*

Please forward your latest catalogue for which I enclose 2 x 1st Class Stamps or £4.11 inc VAT for the Service Manuals Index on PC Disc plus catalogue.

NAME ____________________

ADDRESS ____________________

____________________

____________________

____________ POSTCODE ____________

Photocopy this coupon if you do not wish to cut the magazine

## INFOTECH & STREE

76 Church St, Larkhall, Lanarks, ML9 1HE
*Phone (01698) 883334/888343 or Fax (01698) 884825*

Remember: Not only do we have every sheet ever produced, but we also have

**The World's Largest Collection of SERVICE MANUALS & CIRCUITS**

We are now successfully running a *Library Service* which allows you to borrow any manual you want for as long as you want, and when you need another manual, just return the one you have, plus a £4.95 exchange fee and tell us what you want next.

*Borrow any Service Manual for £4.95 regardless of its size or normal cost*

The cost of this service is a yearly subscription fee of only £59.95. Join now & get a free 'Data Ref Guide'.

**Millions of quality components at lowest ever prices!**

Plus Tools, Watches, Fancy Goods, Toys.
Mail order UK only.

All inclusive prices –
**NO** VAT to add on.
Send 43p stamped self addressed label or envelope for catalogue/clearance list.

At least 2,100 offers to amaze you.

**Brian J Reed**
**6 Queensmead Avenue, East Ewell**
**Epsom, Surrey KT17 3EQ**
**Tel: 0181-393 9055**

VISA

## Cooke International

SUPPLIER OF QUALITY USED TEST INSTRUMENTS

ANALYSERS, BRIDGES, CALIBRATORS, VOLTMETERS, GENERATORS, OSCILLOSCOPES, POWER METERS, ETC. ALWAYS AVAILABLE

ORIGINAL SERVICE MANUALS FOR SALE
COPY SERVICE ALSO AVAILABLE

EXPORT, TRADE AND U.K. ENQUIRIES WELCOME
SEND FOR LISTS OF EQUIPMENT & MANUALS
ALL PRICES EXCLUDE VAT AND CARRIAGE
DISCOUNT FOR BULK ORDERS SHIPPING ARRANGED

OPEN MONDAY TO FRIDAY 9AM-5PM
**Unit Four, Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex, PO22 0EB**
**Tel (+ 44) 01243 545111/2 Fax (+ 44) 01243 542457**
EQUIPMENT & ACCESSORIES PURCHASED

## FREE CATALOGUE

THINK COMPONENTS – THINK CRICKLEWOOD

- TELEVISION & VIDEO SPARES
- RESISTORS & CAPACITORS
- HI-FI GADGETS & SPEAKERS
- TRANSISTORS & I.C.'s
- AUDIOPHILE CAPACITORS
- IN CAR AUDIO
- COMPUTER BOARDS
- TOOLS & TEST EQUIPMENT
- PLUGS SOCKETS & LEADS

Cricklewood Electronics

PLEASE SEND ME A COPY OF THE CRICKLEWOOD CATALOGUE.

Name ____________________

Address ____________________

____________________

____________________

____________________ EPE

PRICES HELD INTO 1996

Cricklewood Electronics Ltd, 40-42 Cricklewood Broadway, London NW2 3ET. Tel: 0181-450 0995 Fax: 0181-208 1441

## N. R. BARDWELL LTD (EPE)

| | | |
|---|---|---|
| 200 | Signal diodes 1N4148 | £1.00 |
| 75 | Rectifier Diodes 1N4001 | £1.00 |
| 50 | Rectifier Diodes 1N4007 | £1.00 |
| 10 | W02 Bridge Rectifiers | £1.00 |
| 5 | NE555 Timer I.C.s | £1.00 |
| 50 | Asstd. Zener Diodes | £1.00 |
| 30 | BC212L Transistors | £1.00 |
| 30 | BC213L Transistors | £1.00 |
| 30 | BC214C Transistors | £1.00 |
| 30 | BC237 Transistors | £1.00 |
| 20 | BC327 Transistors | £1.00 |
| 30 | BC328 Transistors | £1.00 |
| 30 | BC337 Transistors | £1.00 |
| 30 | BC478 Transistors | £1.00 |
| 30 | BC546 Transistors | £1.00 |
| 30 | BC547 Transistors | £1.00 |
| 30 | BC548 Transistors | £1.00 |
| 30 | BC549 Transistors | £1.00 |
| 25 | BC557 Transistors | £1.00 |
| 30 | BC558 Transistors | £1.00 |
| 30 | BC559 Transistors | £1.00 |
| 25 | BC640 Transistors | £1.00 |
| 30 | MPSA42 Transistors | £1.00 |
| 30 | MPSA92 Transistors | £1.00 |
| 20 | 2N3702 Transistors | £1.00 |
| 20 | 2N3904 Transistors | £1.00 |
| 5 | 78L12 12V 100mA Pos Regulators | £1.00 |
| 10 | 79M08 8V 500mA Neg Regulators | £1.00 |
| 25 | 5mm red l.e.d.s | £1.00 |
| 25 | 3mm red l.e.d.s | £1.00 |
| 25 | Asstd. high brightness l.e.d.s | £1.00 |
| 50 | Axial l.e.d.s (Diode package) | £1.00 |
| 12 | Asstd. 7-segment displays | £1.00 |
| 2 | ORP12 light dependant resistors | £1.00 |
| 30 | Asstd. IF transformers | £1.00 |
| 48 | Asstd. coil formers | £1.00 |
| 100 | Asstd. RF chokes (inductors) | £1.00 |
| 30 | Asstd. connectors edge,d.i.l., sil etc | £1.00 |
| 30 | Asstd. d.i.l. sockets up to 40-pin | £1.00 |
| 200 | Asstd. disc ceramic capacitors | £1.00 |
| 80 | Asstd. capacitors 1nF to 1µF | £1.00 |
| 80 | Asstd electrolytic capacitors | £1.00 |
| 10 | 4P3W MBB min. rotary switches | £1.00 |
| 20 | Min. SP/CO slide switches | £1.00 |
| 20 | 1″ glass reed switches | £1.00 |
| 200 | 4N7 mini axial capacitors | £1.00 |
| 24 | 24-pin d.i.l. wire wrap i.c. skts. | £1.00 |
| 1 | 12V motorised volume control 50k | £1.00 |
| 50 | Grommets 6·3mm id, 9·5mm od | £1.00 |
| 100 | c/f ¼W 5% resistors any one value, E24, range 1R to 10M | £0.45 |

Prices include VAT. postage £1.25. Stamp for Lists
288 Abbeydale Road, Sheffield S7 1FL
Phone (0114) 2552886 Fax (0114) 2500689

# OMNI ELECTRONICS

174 Dalkeith Road, Edinburgh EH16 5DX ★ 0131 667 2611

The supplier to use if you're looking for:–

★ A WIDE RANGE OF COMPONENTS AIMED AT THE HOBBYIST

★ COMPETITIVE VAT INCLUSIVE PRICES ★

★ MAIL ORDER – generally by RETURN OF POST ★

★ FRIENDLY SERVICE ★

1995/6 CATALOGUE NOW IN STOCK!

COST: £2.00. Includes vouchers to offset against future purchases.

OPEN: Monday-Thursday 9.15 - 6.00.
Friday 9.15-5.00
Saturday 9.30-5.00

VISA

Mixed metal/carbon film resistors ⅛W E12 series 10 ohms to 1 Megohm ..... 2p
Carbon Film resistors ¼W 5% E24 series 0.51 R to 10MO ..... 1p
100 off per value – 75p. even hundreds per value totalling 1000 ..... £6.00p
Metal Film resistors ¼W 10R to 1 MO 5% E12 series – 1½p. 1% E24 series ..... 2p
Mixed metal/carbon film resistors ½W E24 series 1RO to 10MO ..... 1½p
1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms ..... 5p
Linear Carbon pre-sets 100mW and ¼W 100R to 2M2 E6 series ..... 7p

**Miniature polyster capacitors 250V working for vertical mounting**
.015, .022, .033, .047, .068-4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47 - 8p. 0.68 - 8p. 1.0 - 12p

**Mylar (polyester) capacitors 100V working E12 series vertical mounting**
1000p to 8200p - 3p. .01 to .068 - 4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47/50V - 8p

**Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series**
2% 1.8pf to 47pf - 3p. 2% 56pf to 330pf - 4p. 10% 390p-4700p ..... 4p
Disc/plate ceramics 50V E12 series 1PO to 1000P, E6 Series 1500P to 47000P ..... 2p

**Polystyrene capacitors 63V working E12 series long axial wires**
10pf to 820pf - 5p. 1000pf to 10,000pf - 6p. 12,000pf ..... 7p
741 Op Amp - 20p. 555 Timer – 20p. LM3900 ..... 80p
CMOS 4001 - 20p. 4011 - 22p. 4017 – 40p. 4069UB unbuffered ..... 20p
DIL holders, 8-pin 9p; 14-, 16-, 18-pin 12p; 24-pin 18p; 28-pin 20p; 40-pin 25p.

**ALUMINIUM ELECTROLYTICS (Mfds/Volts)**
1/50, 2.2/50, 4.7/50, 10/25, 10/50 ..... 5p
22/16, 22/25, 22/50, 33/16, 47/16, 47/25, 47/50 ..... 6p
100/16, 100/25 7p; 100/50 ..... 12p
220/16 8p; 220/25, 220/50 10p; 470/16. 470/25 ..... 11p
1000/25 25p; 1000/35, 2200/25 35p; 4700/25 ..... 70p

**Subminiature, tantalum bead electrolytics (Mfds/Volts)**
0.1, 0.22, 0.47, 1.0, 2.2, 3.3 @ 35V – 4.7/16, 6.8/10, 10/6, 10p; 6.8/35, 12p.
4.7/25, 6.8/16, 10/6, 11p; 15/16, 22/6, 33/10, 15p; 10/25, 16p; 10/35, 22/16, 20p.
47/10, 20p; 47/16, 25p; 47/20, 30p; 47/35, 32p; 100/3, 18p; 100/6, 220/6, 20p.

**VOLTAGE REGULATORS**
1A + or – 5V, 8V, 12V, 15V, 18V & 24V - 55p. 100mA. 5.8, 12, 15, V + ..... 30p

**DIODES (piv/amps)**
75/25mA 1N4148 2p. 800/1A 1N4006 4½p. 400/3A 1N5404 14p. 115/15mA OA91 .. 8p
100/1A 1N4002 3½p. 1000/1A 1N4007 5p. 60/1.5A S1M1 5p. 100/1A bridge ..... 25p
400/1A 1N4004 4p. 1250/1A BY 127 10p. 30/150mA OA47 gold bonded ..... 18p
Zener diodes E24 series 3V3 to 33V 400mW - 6p. 1 watt ..... 10p
Battery snaps for PP3 - 7p for PP9 ..... 12p
L.E.D.'s 3mm. & 5mm. Red, Green, Yellow - 10p. Grommets 3mm - 2p. 5mm ..... 2p
Red flashing L.E.D.'s require 9-12V supply only, 5mm ..... 50p
Mains indicator neons with 220k resistor ..... 10p
20mm fuses 100mA to 5A. O. blow 6p.A/surge 10p. Holders, chassis, mounting ..... 6p
High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0mm - 40p. Machines 12V dc ..... £15.00
HELPING HANDS 6 ball joints and 2 croc clips to hold awkward jobs ..... £4.50
AA/HP7 Nicad rechargeable cells 90p each. Universal charger unit ..... £6.50
AA/HP7 zinc/carbon batteries in packs of 4 ..... £1.10 per pack
Glass reed switches with single pole make contacts - 8p. Magnets ..... 20p
0.1" Stripboard 2½" x 1" 9 rows 25 holes - 25p. 3¾ x 2½" 24 rows 37 holes ..... 70p
Jack plugs 2.5 & 3.5m – 14p; Sockets Panel Mtg. 2.5 & 3.5m ..... 10p
Ear pieces 2.5 & 3.5mm, dynamic – 20p; 3.5mm crystal ..... £1.50
**Multi cored solder,** 22G – 8p yard, 18G – 14p yard.

**TRANSISTORS**
BC107/8/9 - 12p. BC547/8/9 - 8p. BC557/8/9 - 8p. BC182, 182L, BC183, 183L, BC184, 184L, BC212, 212L - 10p.
BC327, 337, 337L - 12p. BC727, 737 - 12p. BD135/6/7/8/9 - 25p. BCY70 - 18p. BFY50/51/52 - 20p.
BFX88 - 15p, 2N3055 - 55p, TIP31, 32 - 30p, TIP41, 42 - 40p. BU208A - £1.50, BF195, 197 - 12p
Ionisers with seven year guarantee, 240V AC, list price £16.95 or more ..... £12.50

Do not add VAT. Postage 30p (free over £5). Stamp for list.

## THE CR SUPPLY CO

**127 Chesterfield Rd., Sheffield S8 0RN Tel: 0114 2557771** *Return posting*

**NEW MINI CAMERA and SPECIAL OFFERS**

**NEW – Mini Waterproof TV Camera,** 40 x 40 x 15mm, requires 10V to 16V at 120mA with composite video output (to feed into a Video or a TV with a SCART plug) it has a high resolution of 450 TV lines vertical and 380 TV lines horizontal, electronic auto Iris for nearly dark (1 LUX) to bright sunlight operation and a pinhole lens with a 92 degree field of view, it focuses down to a few CM.It is fitted with a 3-wire lead (12V in gnd and video out). £93.57 + VAT = £109.95 or 10+ £89.32 + VAT = £104.95.

**High** quality Stepping Motor Kits (all including stepping motors) 'Comstep' independent control of two stepping motors by PC (via the Parallel Port) with two motors and software ..... Kit **£67.00**; Built **£99.00**

**Software** support and 4-digital inputs kit ..... **£27.00**

**Power Interface:** 4A kit **£36.00**, 8A kit, **£46.00.**

**Stepper** kit 4 (manual control) includes 200 step stepping motor and control circuit ..... **£23.00**

**Hand Held Transistor Analyser.** It tells you which lead is the base, the collector and emitter and if it is *NPN* or *PNP* or faulty, **£33.45**. Spare 6V battery **£1.20**.

**LEDs** 3mm or 5mm Red or Green **7p** each, Yellow **11p** each.

**Cable Ties 1p** each, **£5.95** per 1000, **£49.50** per 10,000.

**RECHARGEABLE BATTERIES**

**AA** (HP7) 500mAH ..... £0.99
**AA** 700mAH ..... £1.75
**C** 2AH with solder tags ..... £3.60
**D** 4AH with solder tags ..... £4.95
**1/2AA** with solder tags ..... £1.55
**AAA** (HP16) 180mAH ..... £1.75
**AA** 500mAH with solder tags ..... £1.55
**C** (HP11) 1·2AH ..... £2.20
**D** (HP2) 1·2AH ..... £2.60
**PP3** 8·4V 110mAH ..... £4.95
**Sub C** with solder tags ..... £2.50
**1/3 AA** with tags (Philips CTV) ..... £1.95

**Standard Charger,** charges 4 AA cells in 5 hours or 4 Cs or Ds in 12 to 14 hours, plus 1xPP3 (1, 2, 3 or 4 cells may be charged at a time) ..... **£5.95**

**High Power Charger,** as above but charges the Cs and Ds in 5 hours; AAs, Cs and Ds *must* be charged in twos or fours ..... **£10.95**

**Nickel Metal Hydryde AA cells,** high capacity with no memory. If charged at 100mA and discharged at 250mA or less 1100mAH capacity (lower capacity for high discharge rates) ..... **£3.75**

**SPECIAL OFFERS – PLEASE CHECK FOR AVAILABILITY**

**Stick of 4,** 42mm x 16mm NiCad batteries, 171mm x 16mm dia., with red and black leads, 4·8V ..... **£5.95**

**Five button cell,** 6V 280mAH battery with wires (Varta 5 x 250DK) ..... **£2.45**

**Shaded-pole motor,** 240V a.c. 5mm x 20mm shaft, 80mm x 60mm x 55mm, excluding the shaft, ..... **£4.95**

**115V a.c. 80V d.c. motor,** 4mm x 22mm shaft, 50mm dia. x 60mm long body (excluding the shaft) it has a replaceable thermal fuse and brushes ..... **£4.94**each, **£3.95** 100+

**7-Segment,** common anode, l.e.d. display, 12mm ..... **45p**

**LM337K,** TO3 case, Variable regulator **£1.95,** 100+ **£1.44**

**GaAs F.E.T.** low leakage current S8873 ..... **£12.95** each, **£9.95** 10+, **£7.95** 100+

**BS250** *p*-channel MOSFET ..... **45p**
**BC559** transistor ..... **£3.95** per 100
**BC547A** transistor ..... 20 for **£1.00**
**74LS05** Hex inverter ..... **£10.00** per 100
**Used 8748** Microcontroller ..... **£3.50**
**SL952** UHF Limiting amplifier, LC 16 surface mounting package with data sheet ..... **£1.95**
**AM27S02** ..... **£1.25** each; **90p** 100+
**CD4007UB** ..... **10p** 100+, **6p** 1000+

**Sinclair Light Gun,** terminated with a jack plug and PP3 clip, gives a signal when pointed at 50Hz flickering light, with output waveform chart ..... **£3.95**

**DC-DC Converter.** Reliability model V12P5, 12V in, 5V 200mA out, 300V input-to-output isolation, with data ..... **£4.95** each or pack of 10 **£39.50**

**Hour Counter** used 7 digit 240V a.c. 50Hz ..... **£1.45**

**QWERTY** keyboard, 58-key, good quality switches, new ..... **£6.00**

**Airpax** A82903-C large stepping motor 14V 7·5° step, 27 ohm, 68mm dia. body, 6.3mm shaft ..... **£8.95** or **£200** for a box of 30

**Polyester capacitors,** box type, 22.5mm lead pitch
0·9µF 250V d.c. **18p** each, **14p** 100+, **9p** 1000+
1µF 250V d.c. **20p** each, **15p** 100+, **10p** 1000+

**1µF** 50V bipolar electrolytic axial leads, **15p** each, **7·5p** 1000+

**0·22µF** 250V polyester axial leads, **15p** each, 100+ **7·5p** each

**Polypropylene** 1µF 400V d.c. (Wima MKP10) 27.5mm pitch, 32mm x 29mm x 17mm case, **75p** each, **60p** 100+

**Philips** 123 series solid aluminium axial leads, 33µF 10V and 2·2µF 40V **40p** each, **25p** 100+

**Philips** 108 series, long life, 22µF 63V axial ..... **30p** each, **15p** 1000+

**Multilayer AVX** ceramic capacitors, all 5mm pitch, 100V 100pF, 150pF, 220pF, 10,000pF (10n) **10p** each, **5p** 100+, **3.5p** 1000+

**500pF** compression trimmer capacitor ..... **60p**

**40µF** 370V a.c. motor start capacitor (dialectrol type containing no p.c.b.s) ..... **£5.95** or **£49.50** for 10

**Solid carbon resistors,** very low inductance, ideal for r.f. circuits, 27 ohm 2W, 68 ohm 2W **25p** each, **15p** each 100+

We have a range of 0·25W, 0·5W, 1W and 2W solid carbon resistors – please send SAE for list

**P.C. 400W PSU** (Intel part 201035-001) with standard motherboard and five disk drive connectors, fan and mains input/output connectors on back and switch on the side (top for tower case) dims. 212mm x 149mm x 149mm excluding switch, **£26.00** each, **£138.00** for 6

**MX180 Digital Multimeter** 17 ranges, 1000V d.c. 750V a.c. 2Megohm 200mA transistor Hfe 9V and 1.5V battery test ..... **£9.95**

**AMD** 27256-3 EPROMs **£2.00** each, **£1.25** 100+

**Inmac** deluxe anti-glare static control panel, window size 228mm x 161mm, overall size 264mm x 200mm, held to the monitor with hook and loop tape pads ..... **£7.95** each

**DIP switch** 3PCO 12-pin (ERG SDC-3-023) **60p** each, **40p** 100+

**Disk Drive Boxes** for a 5·25 disk drive, with room for a power supply, light-grey plastic 67mm x 268mm x 247mm ..... **£7.95** or **£49.50** for 10

**Handheld Ultrasonic Remote Control** ..... **£3.95**

**CV2486 Gas Relay** 30mm x 10mm dia. with 3-wire terminals, will also work as a neon light ..... **20p** each, or **£7.50** per 100

All products advertised are new and unused unless otherwise stated.

Wide range of CMOS TTL 74HC74F Linear, Transistors kits, rechargeable batteries, capacitors, tools etc. always in stock.

Please add **£1.95** towards P&P. VAT included in all prices

## JPG ELECTRONICS

276-278 Chatsworth Road
Chesterfield S40 2BH
Access Visa Orders:
Tel: (01246) 211202 Fax: (01246)550959
Callers welcome 9.30am to 5.30pm
Monday to Saturday

# ADVERTISERS INDEX

N. R. BARDWELL ..... 247
B.K. ELECTRONICS ..... Cover (iii)
BRIAN J. REED ..... 247
BULL ELECTRICAL ..... Cover (ii)/237
CHATWIN GUITARS (JCG) ..... 245
CIRKIT DISTRIBUTION ..... 238
COMPELEC ..... 245
COOKE INTERNATIONAL ..... 247
CRICKLEWOOD ELECTRONICS ..... 247
CR SUPPLY COMPANY ..... 248
DIRECT CCTV ..... 216
DISPLAY ELECTRONICS ..... 170
ELECTRONICS SERVICE MANUAL ..... 227
EPT EDUCATIONAL SOFTWARE ..... 174
EQUINOX TECHNOLOGIES ..... 203
ESR ELECTRONIC COMPONENTS ..... 180
FLIGHT ELECTRONICS INTERNATIONAL LTD ..... 189
HART ELECTRONIC KITS ..... 173
ICS ..... 247
INFOTECH & STREE ..... 247
INTERCONNECTIONS ..... 202
J&N FACTORS ..... 175
JPG ELECTRONICS ..... 248
LABCENTER ..... 217
LENNARD RESEARCH ..... 219
MAGENTA ELECTRONICS ..... 178/179
MAPLIN ELECTRONICS ..... Cover (iv)
MAURITRON ..... 247
MINICRAFT (DELIC ASSOCIATES) ..... 229
MODERN ELECTRONICS MANUAL ..... 174
NATIONAL COLLEGE OF TECHNOLOGY ..... 202
NICHE SOFTWARE ..... 242
OMNI ELECTRONICS ..... 248
PEAK ELECTRONIC DESIGN ..... 245
PICO TECHNOLOGY ..... 200
QUASAR ELECTRONICS ..... 238
QUICKROUTE SYSTEMS ..... 172
RADIO-TECH LTD ..... 242
ROBINSON MARSHALL UK ..... 190
SEETRAX CAE ..... 229
SHERWOOD ELECTRONICS ..... 245
SKYMASTERS (ACG) ..... 203
SUMA DESIGNS ..... 176
THE SECURITY CENTRE ..... 245
TSIEN ..... 197

**ADVERTISEMENT MANAGER: PETER J. MEW**
**ADVERTISEMENT OFFICES:**
EVERYDAY PRACTICAL ELECTRONICS, ADVERTISEMENTS,
HOLLAND WOOD HOUSE, CHURCH LANE, GREAT HOLLAND,
ESSEX CO13 0JS. Phone/Fax: (01255) 850596

*For Editorial address and phone numbers see page 181.*

Published on approximately the first Friday of each month by Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Printed in England by Benham & Co. Ltd, Colchester, Essex. Distributed by Seymour, Windsor House, 1270 London Road, Norbury, London SW16 4DH. Subscriptions INLAND £24 and OVERSEAS £30 (£47.50 airmail) payable to "Everyday Practical Electronics", Subs Dept, Allen House, East Borough, Wimborne, Dorset BH21 1PF. EVERYDAY PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

# POWER AMPLIFIER MODULES-TURNTABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE (A4) S.A.E., 60p STAMPED FOR CATALOGUE ★

## OMP MOS-FET POWER AMPLIFIERS HIGH POWER, TWO CHANNEL 19 INCH RACK

**THOUSANDS PURCHASED BY PROFESSIONAL USERS**

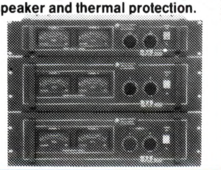
## THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

**FOUR MODELS:- MXF200** (100W + 100W) **MXF400** (200W + 200W) **MXF600** (300W + 300W) **MXF900** (450W + 450W)

**ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN**

**FEATURES:** ★Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

**USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.**

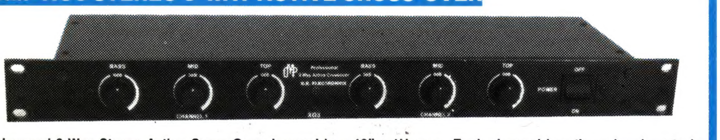


**SIZES:-** MXF200 **W19″xH3½″ (2U)xD11″**
MXF400 **W19″xH5¼″ (3U)xD12″**
MXF600 **W19″xH5¼″ (3U)xD13″**
MXF900 **W19″xH5¼″ (3U)xD14¾″**

**PRICES:- MXF200 £175.00 MXF400 £233.85**
**MXF600 £329.00 MXF900 £449.15**

SPECIALIST CARRIER DEL. £12.50 EACH

## OMP XO3 STEREO 3-WAY ACTIVE CROSS-OVER



dvanced 3-Way Stereo Active Cross-Over, housed in a 19" x 1U case. Each channel has three level controls: ass, mid & top. The removable front fascia allows access to the programmable DIL switches to adjust the ross-over frequency: Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5KHz, all at 24dB per octave. Bass invert switches n each bass channel. Nominal 775mV input/output. Fully compatible with OMP rack amplifier and modules.

**Price £117.44 + £5.00 P&P**

## STEREO DISCO MIXER SDJ3400SE ★ ECHO & SOUND EFFECTS★

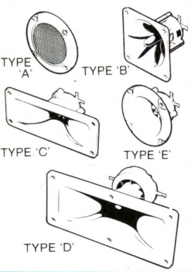
**TEREO DISCO MIXER** with 2 x 7 band & R graphic equalisers with bar graph ED Vu meters. **MANY OUTSTANDING EATURES:- including Echo with repeat & peed control, DJ Mic with talk-over witch, 6 Channels with individual faders lus cross fade, Cue Headphone Monitor. 8 Sound Effects. Useful combination of the ollowing inputs:- 3 turntables (mag), 3 nics, 5 Line for CD, Tape, Video etc.**

**Price £144.99 + £5.00 P&P**

**SIZE: 482 x 240 x 120mm**

## PIEZO ELECTRIC TWEETERS - MOTOROLA

**Join the Piezo revolution!** The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved ransient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required hese units can be added to existing speaker systems of up to 100 watts (more if two are put in series. **FREE XPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.**



**TYPE 'A' (KSN1036A)** 3″ round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi apeakers. **Price £4.90 + 50p P&P.**
**TYPE 'B' (KSN1005A)** 3½″ super horn for general purpose speakers, disco and P.A. systems etc. **Price £5.99 + 50p P&P.**
**TYPE 'C' (KSN1016A)** 2″x5″ wide dispersion horn for quality Hi-Fi systems and quality discos etc. **Price £6.99 + 50p P&P.**
**TYPE 'D' (KSN1025A)** 2″x6″ wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. **Price £9.99 + 50p P&P.**
**TYPE 'E' (KSN1038A)** 3¾″ horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. **Price £5.99 + 50p P&P.**
**LEVEL CONTROL** Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. **Price £4.10 + 50p P&P.**

## *ibl* FLIGHT CASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of the latest speaker technology and enclosure designs. Both models utilize studio quality 12" cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands.

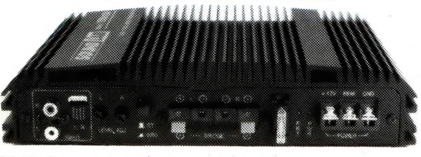
**POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz**

***ibl* FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR**
***ibl* FC 12-200WATTS (100dB) PRICE £175.00 PER PAIR**

SPECIALIST CARRIER DEL. £12.50 PER PAIR

**OPTIONAL STANDS PRICE PER PAIR £49.00**
Delivery £6.00 per pair

## IN-CAR STEREO BOOSTER AMPS



**THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS**

150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono

**ALL POWERS INTO 4 OHMS**

**Features:**
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

**PRICES: 150W £49.99 250W £99.99**
**400W £109.95 P&P £2.00 EACH**

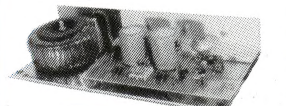
POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.

## OMP MOS-FET POWER AMPLIFIER MODULES

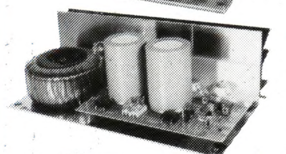
**SUPPLIED READY BUILT AND TESTED.**

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

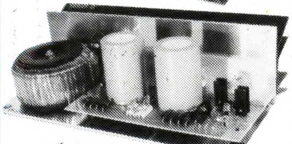
**THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS**



**OMP/MF 100 Mos-Fet** Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
**PRICE £40.85 + £3.50 P&P**

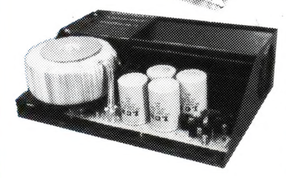


**OMP/MF 200 Mos-Fet** Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
**PRICE £64.35 + £4.00 P&P**



**OMP/MF 300 Mos-Fet** Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
**PRICE £81.75 + £5.00 P&P**

**OMP/MF 450 Mos-Fet** Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
**PRICE £132.85 + £5.00 P&P**



**OMP/MF 1000 Mos-Fet** Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
**PRICE £259.00 + £12.00 P&P**

**NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.**

## LOUDSPEAKERS

**LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (60p STAMPED) FOR COMPLETE LIST.**

**McKenzie and Fane Loudspeakers are also available.**

## EMINENCE:- INSTRUMENTS, P.A., DISCO, ETC

**ALL EMINENCE UNITS 8 OHMS IMPEDANCE**

**8″ 100 WATT R.M.S. ME8-100** GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB. **PRICE £32.71 + £2.00 P&P**
**10″ 100 WATT R.M.S. ME10-100** GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS97dB. **PRICE £33.74 + £2.50 P&P**
**10″ 200 WATT R.M.S. ME10-200** GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID.
RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB. **PRICE £43.47 + £2.50 P&P**
**12″ 100 WATT R.M.S. ME12-100LE** GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR.
RES.FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB. **PRICE £35.64 + £3.50 P&P**
**12″ 100 WATT R.M.S. ME12-100LT** (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. RES. FREQ 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB. **PRICE £36.67 + £3.50 P&P**
**12″ 200 WATT R.M.S. ME12-200** GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID.
RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. **PRICE £46.71 + £3.50 P&P**
**12″ 300 WATT R.M.S ME12-300GP** HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC.
RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB. **PRICE £70.19 + £3.50 P&P**
**15″ 200 WATT R.M.S. ME15-200** GEN. PURPOSE BASS, INCLUDING BASS GUITAR.
RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. **PRICE £50.72 + £4.00 P&P**
**15″ 300 WATT R.M.S. ME15-300** HIGH POWER BASS, INCLUDING BASS GUITAR.
RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB. **PRICE £73.34 + £4.00 P&P**

## EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

**ALL EARBENDER UNITS 8 OHMS** (Except EB8-50 & EB10-50 which are dual impedance tapped @ **4 & 8 ohm)**

**BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND**

**8″ 50watt EB8-50** DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. **PRICE £8.90 + £2.00 P&P**
**10″ 50WATT EB10-50** DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. **PRICE £13.65 + £2.50 P&P**
**10″ 100WATT EB10-100** BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. **PRICE £30.39 + £3.50 P&P**
**12″ 100WATT EB12-100** BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. **PRICE £42.12 + £3.50 P&P**

**FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND**

**5¼″ 60WATT EB5-60TC** (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. **PRICE £9.99 + £1.50 P&P**
**6½″ 60WATT EB6-60TC** (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. **PRICE £10.99 + 1.50 P&P**
**8″ 60WATT EB8-60TC** (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. **PRICE £12.99 + £1.50 P&P**
**10″ 60WATT EB10-60TC** (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. **PRICE £16.49 + £2.00 P&P**

## TRANSMITTER HOBBY KITS

**PROVEN TRANSMITTER DESIGNS** INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

**3W TRANSMITTER** 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
**PRICE £14.85 + £1.00 P&P**

**FM MICRO TRANSMITTER** 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
**PRICE £8.80 + £1.00 P&P**

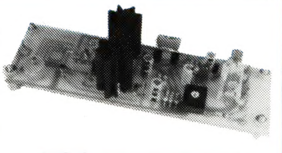


**PHOTO: 3W FM TRANSMITTER**

# B.K. ELECTRONIC

UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA
ESSEX. SS2 6TR.
Tel.: 01702-527572 Fax.: 01702-420243

# With over 14,000 products the new Maplin Catalogue is now bigger than ever

## THE EIFFEL TOWER

Built in 1889 by Alexandre Gustave Eiffel, the Eiffel Tower is 984 feet high and gives an unrivalled view of the whole of Paris.

MAPLIN
ELECTRONICS AND BEYOND
SEPT 1995-AUG 1996
Price £2.95
HOME SECURITY CAMERA
ONLY £149.99
SAVE UP TO £50 WITH VOUCHERS
OFFER VALID UNTIL 30th SEPTEMBER 1996
BRITAIN'S BEST SELLING ELECTRONICS CATALOGUE—OVER 14,000 PRODUCTS!

## THE NEW MAPLIN CATALOGUE

Built for 1996 by Maplin, the new catalogue is almost 1,200 pages long and gives an unrivalled view of the whole world of electronics.

**Now Only £2.95**

8-Way 100A Switched Consumer Unit £30.99

**VAST RANGE OF ELECTRICAL FITTINGS AND CABLES**

**RANGE OF SATELLITE RECEIVERS AND ACCESSORIES FROM 64p TO £660**

Satwalker Satellite Dish Rotator £179.99

Sport 500 Helicopter Kit £129.99

**RADIO CONTROL MODELS, CONTROL GEAR AND SPARES FROM 99p TO £400**

**OVER 400 PAGES OF ELECTRONIC COMPONENTS FROM PRESETS TO PIC CHIPS**

**JUST LOOK AT THESE SUPERB EXAMPLES!**

Advantage Wired Burglar Alarm Kit £99.95

**HOME, CAR AND PERSONAL SECURITY FROM £7 TO £200**

**OVER 300 KITS FOR YOU TO BUILD FROM £5 TO £599**

Electronic Siren Sound Generator Kit

Magellan GPS2000 Personal Navigator £234.99

**RANGE OF NAVIGATION AIDS FROM £13 TO £560**

**OVER 100 PAGES OF COMPUTER AND NETWORK PRODUCTS**

Safertap Non-Disruptive LAN Access Port £23.99

MAPLIN
ELECTRONICS AND BEYOND

**Get your copy now from WHSMITH, John Menzies and Maplin stores nationwide**
**Or order direct NOW on 01702 554161**

Catalogue Mail order Price £3.45 (inc p&p). Prices refer to the 1996 Maplin Catalogue and are inclusive of VAT. All items are subject to availability. E&OE. Maplin Electronics, P.O. Box 3, Rayleigh, Essex, England SS6 8LR.